PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2004-012127
(43)Date of publication of application : 15.01.2004

(51)Int.Cl. F25D 19/00
F25B 1/00
F25D 11/00

(21)Application number : 2003-344079
(22)Date of filing : 02.10.2003

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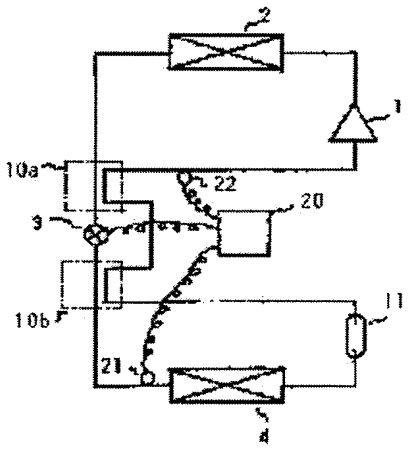
(54) REFRIGERATOR USING INFLAMMABLE REFRIGERANT

(57)Abstract:
PROBLEM TO BE SOLVED: To improve apparatus energy efficiency and enhance safety in case of refrigerant leakage in a refrigerating and air conditioning device using an inflammable refrigerant with a very small adverse effect to the earth environment.
SOLUTION: In a refrigerating cycle comprised by sequentially connecting a compressor 1, a condenser 2, a throttling device 3 and an evaporator 4 by refrigerant piping using and communicating the inflammable refrigerant as a refrigerant, the throttling device is composed of a flow control valve capable of continuously regulating an opening of the throttling device, and a valve opening of the flow control valve is controlled by detecting a refrigerant state at a compressor inlet.



1. 圧縮機
2. 凝縮器
3. 電気式膨張弁（流量制御弁）
4. 蒸発器
10a、10b. 熱回収熱交換器
11. ヘッダー
20. コントローラ（制御手段）
21、22. サーミスタ

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
A refrigerator comprising:
A refrigerating cycle which connects a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, and circulates an inflammable refrigerant as a refrigerant.
A heat recollection heat exchanger which cools said inflammable refrigerant which constituted said collimator from a flow control valve in which opening adjustment is possible, and came out of said condenser between an outlet side of said condenser, and an entrance side of said evaporator with an inhalation refrigerant of said compressor.

[Claim 2]
The refrigerator according to claim 1 providing said heat recollection heat exchanger between an outlet side of said condenser, and an entrance side of said liquid flow control valve.
[Claim 3]
The refrigerator according to claim 1 providing said heat recollection heat exchanger between an outlet side of said liquid flow control valve, and an entrance side of said evaporator.
[Claim 4]
The refrigerator comprising according to any one of claims 1 to 3:
A detection means to detect a refrigerant state of a compressor inlet.
A control means which controls a valve opening of a flow control valve based on said detected refrigerant state.

[Claim 5]
Make said detection means into an inhalation degree-of-superheat detection means of a compressor, and said control means, The refrigerator according to claim 4 enlarging an opening of a flow control valve at the time of a value with this bigger inhalation degree of superheat than a designed value, and controlling to make an opening of a flow control valve small at the time of a value whose inhalation degree of superheat is smaller than said designed value.
[Claim 6]
The refrigerator comprising according to any one of claims 1 to 3:
A detection means to detect a refrigerant state of a compressor exit.
A control means which controls a valve opening of a flow control valve based on said detected refrigerant state.

[Claim 7]
Make said detection means into a discharge temperature detection means of a compressor, and said control means, The refrigerator according to claim 6 enlarging an opening of a flow control valve at the time of a value with this bigger discharge temperature than a predetermined temperature, and controlling to make an opening of a flow control valve small at the time of a value whose discharge temperature is smaller than said predetermined temperature.

[Claim 8]
The refrigerator comprising according to any one of claims 1 to 3:
A detection means to detect a refrigerant state of an evaporator exit.
A control means which controls a valve opening of a flow control valve based on said detected refrigerant state.

[Claim 9]
Make said detection means into an outlet refrigerant degree-of-superheat detection means of an evaporator, and said control means, The refrigerator according to claim 8 enlarging an opening of a flow control valve at the time of a value with this bigger outlet refrigerant degree of superheat than a designed value, and controlling to make an opening of a flow control valve small at the time of a value whose outlet refrigerant degree of superheat is smaller than said designed value.
[Claim 10]
The refrigerator comprising according to any one of claims 1 to 3:
A detection means to detect a refrigerant state of a flow control valve.
A control means which controls a valve opening of a flow control valve based on said detected refrigerant state.

[Claim 11]
Make said detection means into a refrigerant supercooling degree detection means of a flow control valve, and said control means, The refrigerator according to claim 10 enlarging an opening of a flow control valve at the time of a value with this bigger refrigerant supercooling degree than a designed value, and controlling to make an opening of a flow control valve small at the time of a value whose refrigerant supercooling degree is smaller than said designed value.
[Claim 12]
The refrigerator according to any one of claims 1 to 3 provided with a control means controlled to make a valve opening of a flow control valve into full close at the time of a compressor stop.
[Claim 13]
The refrigerator comprising according to any one of claims 1 to 3:
A leakage detection means to detect refrigerant disclosure from a refrigerating cycle.
A control means controlled to make a valve opening of a flow control valve into full close when refrigerant disclosure is detected by said leakage detection means.

[Claim 14]
The refrigerator according to any one of claims 1 to 3 providing a capillary tube in the upper stream or the lower stream of a flow control valve.
[Claim 15]
The refrigerator according to any one of claims 1 to 3 providing a capillary tube in a flow control valve and parallel.
[Claim 16]
The refrigerator according to any one of claims 1 to 15 making a compressor into an inverter drive with variable number of rotations.
[Claim 17]
A refrigerator comprising:
A refrigerating cycle which connects a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, and circulates an inflammable refrigerant as a refrigerant.
A heat recollection heat exchanger which cools said inflammable refrigerant which made said compressor an inverter drive with variable number of rotations, and came out of said condenser between an outlet side of said condenser, and an entrance side of said evaporator with an inhalation refrigerant of said compressor.

[Claim 18]
The refrigerator comprising according to claim 17:

A load detecting means which detects load of a refrigerator.
A control means which controls number of rotations of a compressor according to load detected by said load detecting means.

[Claim 19]
The refrigerator comprising according to claim 17:
A warehouse outside temperature degree detection means to detect the degree of warehouse outside temperature of a refrigerator.
A control means which controls number of rotations of a compressor according to the degree of warehouse outside temperature detected by said warehouse outside temperature degree detection means.

[Claim 20]
The refrigerator comprising according to claim 17:
A temperature-inside detection means to detect temperature inside of a refrigerator.
A control means which controls number of rotations of a compressor according to temperature inside detected by said temperature-inside detection means.

[Claim 21]
A refrigerator comprising:
A refrigerating cycle which connects a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, and circulates an inflammable refrigerant as a refrigerant.
A heat recollection heat exchanger which cools said inflammable refrigerant which said compressor was made into an inverter drive with variable number of rotations, and constituted said collimator from a flow control valve in which opening adjustment is possible, and came out of said condenser between an outlet side of said condenser, and an entrance side of said evaporator with an inhalation refrigerant of said compressor.

[Claim 22]
The refrigerator comprising according to claim 21:
A revolution-rate-detection means to detect number of rotations of a compressor.
A control means which controls a valve opening of a flow control valve according to compressor number of rotations detected by said revolution-rate-detection means.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
This invention relates to the refrigerator using the refrigerant which does not have an adverse effect on earth environment, such as ozone layer depletion and global warming.
[Background of the Invention]
[0002]
Now, the refrigerant of a chlorofluocarbon system is used for the refrigerant of the freezing refrigerator. When emitted to the atmosphere also in a chlorofluocarbon system refrigerant, in order that a CFC system and a HCFC system refrigerant may destroy an ozone layer, the shift to a HFC system chlorofluocarbon refrigerant is advanced. In the home freezing refrigerator, R134a which is a HFC system refrigerant is used widely.
[0003]
Drawing 10 is a figure showing the refrigerant circuit composition of a domestic refrigerator, and the capillary tube a condenser and whose 3 1 is collimators as for a compressor and 2, and 4 are evaporators in a figure. The capillary tube 3 and the suction piping of the compressor 1 are soldered, and constitute the heat recollection heat exchanger 10. Furthermore, the header 11 in which the surplus refrigerant by which it is generated at the time of a change of load, etc. is accumulated is formed in outlet side piping of the evaporator 4. 40 is a fan for heat dissipation, and during compressor 1 operation, it also operates the fan 40 for heat dissipation, and during the compressor 1 stop, it is controlled so that the fan 40 for heat dissipation also stops.
[0004]
Next, operation of the home freezing refrigerator using this conventional chlorofluocarbon system refrigerant is explained using the pressure-enthalpy diagram shown in drawing 11. It flows into (the A point in a figure), and the condenser 2, and is cooled by the open air etc., and the refrigerant vapor of the high temperature high pressure which came out of the compressor 1 is condensed to a gas-liquid two phase state (B point in a figure). The gas-liquid two-phase refrigerant which came out of the condenser 2 flows into the capillary tube 3, is decompressed, and turns into a low-pressure gas-liquid two-phase refrigerant. Since the capillary tube 3 constitutes the suction piping and the heat recollection heat exchanger 10 of the compressor 1, the refrigerant which passes along the capillary tube 3 is cooled by the suction piping of the compressor 1 (C point in a figure). This low-pressure gas-liquid two-phase refrigerant flows into the evaporator 4, cools the inside of a refrigerator warehouse, will be in a low-pressure saturated vapor state, and will flow out the evaporator 4 (D point in a figure). This low-pressure vapor refrigerant flows into the heat recollection heat exchanger 10 through the header 11, is heated with the refrigerant which passes along the capillary tube 3, serves as low-pressure overheated steam, and is again inhaled by the compressor 1 (E point in a figure).
[0005]
However, this HFC system refrigerant is a substance which promotes global warming, when air discharge is carried out.
Using natural refrigerants which do not worsen earth environment, such as a hydrocarbon

refrigerant and ammonia, as a refrigerant of a refrigerator is examined.
As a refrigerator using this inflammable refrigerant, there are some which were shown, for example in JP,8-178481,A. Although influence on global warming is dramatically small as a refrigerant of this freezing refrigerator, hydrocarbon system refrigerants in which an inflammability is shown, such as propane and butane, are used. The inflammable refrigerant detection sensor is installed near the refrigerant piping terminal area of this freezing refrigerator.

[0006]
From the piping connection of the refrigerating cycle, etc., when an inflammable refrigerant is revealed, an inflammable refrigerant detection sensor detects this and it is controlled to transmit a stop signal to the compressor 1.
It is controlled not to lead to explosion, even if an inflammable refrigerant should be revealed.

[Patent documents 1] JP,8-178481,A
[Description of the Invention]
[Problem(s) to be Solved by the Invention]
[0007]
In the above conventional refrigerators, in order to control global warming, the very small hydrocarbon system refrigerant of influence on global warming is used as a refrigerant of a refrigerator. However, in order to control global warming, it is important not only a refrigerant's own global warming but to control the global warming by the power use of a refrigerator. That is, it also becomes an important technical problem to raise the energy efficiency of a refrigerator.
[0008]
Even if a domestic refrigerator changes [the load of refrigerators, such as outdoor-air-temperature change,], in order that temperature inside may be controlled uniformly, the compressor is performing intermittent operation and it becomes important for the improvement in energy efficiency of a refrigerator to make small the energy loss by this compressor intermittent operation.
[0009]
In order to improve the safety at the time of inflammable refrigerant use furthermore, it is important to prevent the blockade by preventing the liquid back to a compressor, or controlling compressor discharge temperature properly, and raising the reliability of a compressor, or getting a foreign matter etc. blocked in a converging section, and to raise the reliability of a refrigerating cycle. That is, it is necessary to prevent beforehand the ignition accident by disclosure of the inflammable refrigerant by the time of the parts replacement in the commercial scene of the refrigerator using an inflammable refrigerant, etc., and to raise the safety of a refrigerator further. When reduce the refrigerant amount with which a refrigerator is furthermore filled up, the refrigerant disclosure from apparatus is controlled or an emergency refrigerant disclosure arises, it is important to diffuse a refrigerant at an early stage so that it may not become inflammable concentration.
[0010]
This invention was made in order to solve the above problems, in the refrigerator using the very small inflammable refrigerant of the adverse effect to earth environment, it raises the energy efficiency of apparatus, and relates to the refrigerator which moreover improved safety and reliability.
[Means for Solving the Problem]
[0011]
A refrigerator concerning this invention connects a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, is provided with a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant, and constitutes said collimator from a flow control valve in which opening adjustment is possible.
[0012]
It has a detection means to detect a refrigerant state of a compressor inlet, and a control means which controls a valve opening of a flow control valve based on said detected refrigerant state.

[0013]
Said detection means is made into an inhalation degree-of-superheat detection means of a compressor, an opening of a flow control valve is enlarged at the time of a value in which this inhalation degree of superheat of said control means is bigger than a designed value, and it controls to make an opening of a flow control valve small at the time of a value whose inhalation degree of superheat is smaller than said designed value.
[0014]
It has a detection means to detect a refrigerant state of a compressor exit, and a control means which controls a valve opening of a flow control valve based on said detected refrigerant state.
[0015]
Said detection means is made into a discharge temperature detection means of a compressor, an opening of a flow control valve is enlarged at the time of a bigger value than a temperature predetermined [control means / said] in this discharge temperature, and it controls to make an opening of a flow control valve small at the time of a value whose discharge temperature is smaller than said predetermined temperature.
[0016]
It has a detection means to detect a refrigerant state of an evaporator exit, and a control means which controls a valve opening of a flow control valve based on said detected refrigerant state.
[0017]
Make said detection means into an outlet refrigerant degree-of-superheat detection means of an evaporator, and said control means, An opening of a flow control valve is enlarged at the time of a value with this bigger outlet refrigerant degree of superheat than a designed value, and it controls to make an opening of a flow control valve small at the time of a value whose outlet refrigerant degree of superheat is smaller than said designed value.
[0018]
It has a detection means to detect a refrigerant state of a flow control valve, and a control means which controls a valve opening of a flow control valve based on said detected refrigerant state.
[0019]
Make said detection means into a refrigerant supercooling degree detection means of a flow control valve, and said control means, An opening of a flow control valve is enlarged at the time of a value with this bigger refrigerant supercooling degree than a designed value, and it controls to make an opening of a flow control valve small at the time of a value whose refrigerant supercooling degree is smaller than said designed value.
[0020]
It has a control means controlled to make a valve opening of a flow control valve into full close at the time of a compressor stop.
[0021]
It has a leakage detection means to detect refrigerant disclosure from a refrigerating cycle, and a control means controlled to make a valve opening of a flow control valve into full close when refrigerant disclosure is detected by said leakage detection means.
[0022]
A capillary tube is provided in the upper stream or the lower stream of a flow control valve.
[0023]
A capillary tube is provided in a flow control valve and parallel.
[0024]
Let a compressor be an inverter drive with variable number of rotations.
[0025]
A compressor, a condenser, an collimator, and an evaporator are connected one by one by refrigerant piping, and it has a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant, and let said compressor be an inverter drive with variable number of rotations.
[0026]
It has a load detecting means which detects load of a refrigerator, and a control means which controls number of rotations of a compressor according to load detected by said load detecting

means.
[0027]
It has a warehouse outside temperature degree detection means to detect the degree of warehouse outside temperature of a refrigerator, and a control means which controls number of rotations of a compressor according to the degree of warehouse outside temperature detected by said warehouse outside temperature degree detection means.
[0028]
It has a temperature-inside detection means to detect temperature inside of a refrigerator, and a control means which controls number of rotations of a compressor according to temperature inside detected by said temperature-inside detection means.
[0029]
Connect a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, have a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant, and said compressor is made into an inverter drive with variable number of rotations, and said collimator consists of flow control valves in which opening adjustment is possible.
[0030]
It has a revolution-rate-detection means to detect number of rotations of a compressor, and a control means which controls a valve opening of a flow control valve according to compressor number of rotations detected by said revolution-rate-detection means.
[0031]
A compressor, a condenser, an collimator, and an evaporator are connected one by one by refrigerant piping, it has a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant, and a fan for heat dissipation, and intensity of refrigerant piping near [said / for heat dissipation] the fan is made weaker than the other refrigerant piping intensity.
[0032]
A fan for heat dissipation is operated during a compressor stop.
[Effect of the Invention]
[0033]
According to this invention, as explained above A compressor, a condenser, an collimator, Since an evaporator is connected one by one by refrigerant piping, it has a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant and said collimator is constituted from a flow control valve in which opening adjustment is possible, the refrigerator in which energy efficiency is high and the reliability of a compressor is moreover high can be provided.
[0034]
Since it had a detection means to detect the refrigerant state of a compressor inlet, and the control means which controls the valve opening of a flow control valve based on said detected refrigerant state, the inflow of the liquid cooling intermediation to a compressor can be prevented certainly, and improvement in reliability of a compressor and improvement in reliability of a refrigerator can be aimed at. The refrigerator which has few refrigerant fill rations and where energy efficiency is still higher can be provided.
[0035]
Make said detection means into the inhalation degree-of-superheat detection means of a compressor, and said control means, The opening of a flow control valve is enlarged at the time of a value with this bigger inhalation degree of superheat than a designed value, and since it controls to make the opening of a flow control valve small at the time of the value whose inhalation degree of superheat is smaller than said designed value, the inhalation refrigerant degree of superheat of a compressor is appropriately maintainable.
[0036]
Since it had a detection means to detect the refrigerant state of a compressor exit, and the control means which controls the valve opening of a flow control valve based on said detected refrigerant state, degradation of refrigerating machine oil and the reliability deterioration of the compressor due to a viscosity down can be prevented. Furthermore piping **** by sludge can be prevented, and the refrigerator where energy efficiency is high can be obtained.
[0037]

Make said detection means into the discharge temperature detection means of a compressor, and said control means, The opening of a flow control valve is enlarged at the time of a value with this bigger discharge temperature than a predetermined temperature, and since it controls to make the opening of a flow control valve small at the time of the value whose discharge temperature is smaller than said predetermined temperature, the discharged refrigerant temperature of a compressor is appropriately maintainable.

[0038]

Since it had a detection means to detect the refrigerant state of an evaporator exit, and the control means which controls the valve opening of a flow control valve based on said detected refrigerant state, Unevaporated liquid cooling intermediation can flow out of an evaporator, or decline in the heat exchanging efficiency of an evaporator can be prevented, and the refrigerator where energy efficiency is high can be realized.

[0039]

Make said detection means into the outlet refrigerant degree-of-superheat detection means of an evaporator, and said control means, The opening of a flow control valve is enlarged at the time of a value with this bigger outlet refrigerant degree of superheat than a designed value, and since it controls to make the opening of a flow control valve small at the time of the value whose outlet refrigerant degree of superheat is smaller than said designed value, the degree of superheat of the outlet refrigerant of an evaporator is appropriately maintainable.

[0040]

Since it had a detection means to detect the refrigerant state of a flow control valve, and the control means which controls the valve opening of a flow control valve based on said detected refrigerant state, there is no change of a refrigerant flow rate, energy efficiency is high and a refrigerator without generating of a refrigerant flow sound can be provided.

[0041]

Make said detection means into the refrigerant supercooling degree detection means of a flow control valve, and said control means, The opening of a flow control valve is enlarged at the time of a value with this bigger refrigerant supercooling degree than a designed value, and since it controls to make the opening of a flow control valve small at the time of the value whose refrigerant supercooling degree is smaller than said designed value, the supercooling degree of the entrance refrigerant of a flow control valve is appropriately maintainable.

[0042]

Since it controls to make the valve opening of a flow control valve into full close at the time of a compressor stop, the energy loss at the time of compressor intermittent operation is reduced, and the refrigerator where energy efficiency is high can be realized.

[0043]

Since it controls to make the valve opening of a flow control valve into full close when the refrigerant disclosure from a refrigerating cycle is detected, a refrigerant leak rate can be reduced and the refrigerator where safety is high can be obtained.

[0044]

Since a capillary tube is provided in the upper stream or the lower stream of a flow control valve, **** of the flow control valve by sludge can be prevented, and a reliable refrigerator can be provided.

[0045]

Since a capillary tube is provided in a flow control valve and parallel, a small cheap flow control valve can be used, moreover **** of the flow control valve by sludge can be prevented, and a reliable refrigerator can be provided.

[0046]

Since a compressor is made into an inverter drive with variable number of rotations, the cycle conditions at the time of compressor number-of-rotations change can be controlled the optimal, and the refrigerator where energy efficiency is high can be provided.

[0047]

Since a compressor, a condenser, an collimator, and an evaporator are connected one by one by refrigerant piping, it has a refrigerating cycle which circulates an inflammable refrigerant as a

refrigerant and a compressor is made into an inverter drive with variable number of rotations, the refrigerator where energy efficiency is high can be provided.
[0048]
Since the load of a refrigerator is detected and the number of rotations of a compressor is controlled according to this load, even if the load of a refrigerator changes, a refrigerator can be operated in the state where energy efficiency is always high.
[0049]
Since the degree of warehouse outside temperature of a refrigerator is detected and the number of rotations of a compressor is controlled according to this degree of warehouse outside temperature, even if the degree of warehouse outside temperature changes, a refrigerator can be operated in the state where energy efficiency is always high.
[0050]
Since the temperature inside of a refrigerator is detected and the number of rotations of a compressor is controlled according to this temperature inside, even if temperature inside changes, a refrigerator can be operated in the state where energy efficiency is always high.
[0051]
Connect a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, have a refrigerating cycle which circulates an inflammable refrigerant as a refrigerant, and make a compressor into an inverter drive with variable number of rotations, and. Since an collimator is constituted from a flow control valve in which opening adjustment is continuously possible, the input of a compressor can be reduced according to load and the cycle conditions at the time of compressor number-of-rotations change can moreover be controlled the optimal, the refrigerator in which energy efficiency is high and it is reliable can be provided.
[0052]
Since the number of rotations of a compressor is detected and the valve opening of a flow control valve is controlled according to this compressor number of rotations, the refrigerator in which it is cheap, and is reliable and energy efficiency is moreover high can be obtained.
[0053]
The refrigerating cycle which connects a compressor, a condenser, an collimator, and an evaporator one by one by refrigerant piping, and circulates an inflammable refrigerant as a refrigerant, Since it has a fan for heat dissipation and intensity of the refrigerant piping near [for heat dissipation] the fan is made weaker than the other refrigerant piping intensity, the safety at the time of refrigerant disclosure can be raised substantially.
[0054]
Since the fan for heat dissipation is operated during a compressor stop, safety can be substantially raised also to the refrigerant disclosure at the time of a compressor stop.
[Best Mode of Carrying Out the Invention]
[0055]
Embodiment 1.
Drawing 1 is a refrigerant circuit figure of the home freezing refrigerator in which an example of this embodiment of the invention is shown, and identical codes show the same portion as a device conventionally. In a figure, 4 which a condenser and 3 are electric type expansion valves which are flow control valves, and 1 drives a compressor and 2 with a stepping motor, and can adjust the opening with the electrical signal from the outside arbitrarily is an evaporator. As a refrigerant of this freezing refrigerator, although an inflammability is shown, the adverse effect to global warming uses the very small hydrocarbon system refrigerant R600a (isobutane).
[0056]
Piping of the upper stream of the electric type expansion valve 3 and the suction piping of the compressor 1 are soldered, and constitute the heat recollection heat exchanger 10a. Furthermore, piping of the lower stream of the electric type expansion valve 3 and the suction piping of the compressor 1 are soldered, and constitute the heat recollection heat exchanger 10b. 20 is a controller of the electric type expansion valve 3, and the signal from the thermo sensitive register 21 which detects the inlet temperature of the evaporator 4, and the thermo sensitive register 22 which detects the intake air temperature of the compressor 1 is inputted,

and it outputs an opening command to the electric type expansion valve 3 based on these signals.

[0057]

Next, operation is explained. The home freezing refrigerator is controlling the temperature in a refrigerator warehouse by intermittent operation of a compressor uniformly fundamentally. So, the operation which a compressor is operating is explained first here. It flows into the condenser 2, and is cooled by the open air etc., and the refrigerant vapor of high temperature high pressure with which it came out of the compressor 1 at the time of compressor operation is condensed to a gas-liquid two phase state. It is cooled with the inhalation refrigerant of the compressor 1 by the heat recollection heat exchanger 10a, and it flows into the electric type expansion valve 3, is decompressed, and is further cooled by the heat recollection heat exchanger 10b, and the gas-liquid two-phase refrigerant which came out of the condenser 2 turns into a low-pressure gas-liquid two-phase refrigerant. This low-pressure gas-liquid two-phase refrigerant flows into the evaporator 4, cools the inside of a refrigerator warehouse, and flows out the evaporator 4. This vapor refrigerant of the low pressure which flowed out flows into the heat recollection heat exchangers 10b and 10a, is heated with the refrigerant of the lower stream of an electric type expansion valve, and the upper stream, serves as low-pressure overheated steam, and is again inhaled by the compressor 1. On the other hand, the electric type expansion valve 3 is changed into the full-close state during the compressor stop. For this reason, the refrigerant which exists in the high-tension side of cycles, such as inside of the condenser 2, does not move to the low-tension side of the cycles in the evaporator 4 etc., but holds the refrigerant distribution under compressor operation.

[0058]

Next, operation of the controller 20 under compressor operation is explained. The inlet refrigerant temperatures T1 of the evaporator 4 detected from the thermo sensitive register 21 and the inhalation refrigerant temperature T2 of the compressor 1 detected from the thermo sensitive register 22 are inputted into the controller 20, and the degree of superheat of the inhalation refrigerant of the compressor 1 is calculated by this two temperature-gradients T2-T1. And an opening command is outputted to the electric type expansion valve 3 so that this degree-of-superheat T2-T1 may become the proper designed value defined beforehand, for example, 50 **. At namely, the time of a value with a bigger compressor inhalation degree of superheat detected with the thermo sensitive registers 21 and 22 than a designed value. An opening command is outputted so that the opening of the electric type expansion valve 3 may be made larger than the present, and at the time of the value whose compressor inhalation degree of superheat conversely detected with the thermo sensitive registers 21 and 22 is smaller than a designed value, an opening command is outputted so that the opening of the electric type expansion valve 3 may be made smaller than the present.

[0059]

Since the capillary tube which is a fixed diaphragm was used with the collimator in the conventional refrigerator, depending on the service condition of a refrigerator. A compressor inhalation refrigerant degree of superheat always could not control to an optimum value at the time of compressor start, etc., but liquid cooling intermediation flowed into the compressor, and the technical problem to which the reliability of a compressor falls due to liquid compression, the viscosity down of the lubricating oil in a compressor, etc. occurred. However, in this embodiment, in the domestic refrigerator which is controlling the temperature in a warehouse by intermittent operation of a compressor uniformly, since it is controlling by the electric type expansion valve 3 so that the inhalation refrigerant state of the compressor 1 always serves as an optimum value also including the time of compressor start, The inflow of the liquid cooling intermediation to a compressor can be prevented certainly, and the improvement in reliability of a compressor, i.e., the improvement in reliability of a refrigerator, can be aimed at. Since the refrigerant state of an evaporator exit is maintainable in the high saturated vapor state of a heat-conducting characteristic, the heat exchange characteristic of an evaporator can also be controlled in the always good state, and can raise the energy efficiency of a refrigerator. Since unnecessary liquid cooling intermediation is reducible, the refrigerant fill ration in a cycle can be reduced and danger

at the time of an emergency refrigerant disclosure can be made small.
[0060]
When refrigerator temperature inside reaches a proper temperature and the compressor 1 has stopped, the electronic formula expansion valve 3 is made into full close, and the controller is controlling by this embodiment to prevent refrigerant movement to the low-tension side from the high-tension side of a cycle. In the home freezing refrigerator which is controlling the inside of a refrigerator warehouse by intermittent operation of a compressor to a fixed temperature, if a refrigerant moves to depression from a high pressure part at the time of a compressor stop, the energy efficiency of a refrigerator will fall. This is to warm an evaporator, or for the refrigerant amount of a high pressure part to decrease, to be in a refrigerant insufficient state by refrigerant movement at the time of a compressor stop, at the time of a compressor reboot, and for inefficient operational status to continue for a while.
[0061]
The flow by which a hydrocarbon system refrigerant passes along the big portion of flow resistance, such as a nozzle (a part for for example, the narrow part in the electronic formula expansion valve 3 of drawing 1), compared with a chlorofluocarbon system refrigerant shows the increasing tendency. Therefore, although the flow resistance of a capillary tube or the compressor 1 had controlled refrigerant movement of a high pressure part and depression in the refrigerator using the conventional chlorofluocarbon system refrigerant, In the case where a hydrocarbon system refrigerant is used, the flow resistance of a capillary tube or a compressor is not enough, and the refrigerant movement magnitude of depression increases from a high pressure part rather than a chlorofluocarbon system refrigerant.
[0062]
The volumetric flow rate G of the gas which passes along a nozzle
$G=v*F*\{2/(kappa+1)\}^{\{1/(kappa-1)\}}$
$*[*\{kappa/(kappa+1)\} * (P/v)]^{0.5}$ ... (formula 1)
It comes out and asks. As for a nozzle cross-section area and kappa, high voltage and v of the ratio of specific beat and P are [F] specific volume bulk here. The move refrigerant flow rate of depression is calculated using this formula from the high pressure part of the hydrocarbon system refrigerant R600a and the chlorofluocarbon system refrigerant R134a. When the condensation temperature immediately after a compressor stop of a refrigerator shall be 30 ** and evaporating temperature is made into -30 **, the property value of R600a is kappa= 1. 138, P=404kPa, v= 0. It is 09561-m3/kg and the property value of R134a is kappa= 1. 198, P=770kPa, v= 0. It is set to 02667-m3/kg. If these property values are substituted for an upper type and the move refrigerant flow rate in the same nozzle cross-section area of R600a and R134a is calculated,
G600a/G134a=1. 22
It becomes. That is, the move refrigerant flow rate from the high pressure part of R600a to depression becomes large 22% rather than R134a, and the energy efficiency of the refrigerator using R600a falls rather than R134a at this rate.
[0063]
So, in order to prevent and carry out refrigerant movement to depression from the high pressure part at the time of a compressor stop of the refrigerator which used this R600a, the electronic formula expansion valve 3 is controlled by this embodiment to full close at the time of a compressor stop. As a result, the decline in the energy efficiency of the refrigerator by refrigerant movement to depression from the high pressure part at the time of a compressor stop is prevented, and can provide the freezing refrigerator using an inflammable refrigerant with high energy efficiency. Although this embodiment showed the example which controls an electric type expansion valve to full close at the time of a compressor stop, Even if refrigerant disclosure should occur when a refrigerant leak detector was formed in the inside of a refrigerator, and refrigerant disclosure was detected and being controlled to make an electronic formula expansion valve into full close, a refrigerant leak rate can be lessened and the safety of a refrigerator can be improved further.

[0064]
Although this embodiment explained the example using the electronic formula expansion valve which can adjust an opening with an electrical signal arbitrarily as an collimator, the temperature type expansion valve which does not restrict to this and adjusts an opening mechanically may be sufficient. Although the example which controls the degree of superheat of a compressor inhalation refrigerant to an optimum value was shown, the intake air temperature of a compressor itself may be controlled by this embodiment to an optimum value, for example, 30 **.

[0065]
In this embodiment, piping of the upper stream of the electric type expansion valve 3 and the lower stream and the suction piping of the compressor 1 constitute the heat recollection heat exchangers 10a and 10b, the enthalpy of the refrigerant from an evaporator exit to compressor inhalation is collected, and the energy efficiency of a cycle is raised. Although the example which constituted the heat recollection heat exchanger from this embodiment by piping of the upper stream of the electric type expansion valve 3 and the lower stream and the suction piping of the compressor 1 was shown, it does not restrict to this, and the same effect is demonstrated even if it constitutes a heat recollection heat exchanger only from upper piping and compressor suction piping of the electric type expansion valve 3. A heat recollection heat exchanger may consist of only downstream piping and compressor suction piping of the electric type expansion valve 3.
[0066]
Although the case where the hydrocarbon refrigerant isobutane (R600a) which has an inflammability was used as a refrigerant in this embodiment was explained, it does not restrict to this, They may be natural refrigerants, such as hydrocarbon refrigerants, such as butane (R600) and propane (R290), and ammonia, or these mixed refrigerants. R32, R152a, etc. may be a small HFC system chlorofluocarbon refrigerant of a global warming potential, or its mixed refrigerant.
[0067]
In this embodiment, although not clearly shown in particular about refrigerating machine oil, it may be synthetic oil, such as mineral oil, alkylbenzene and ester oil, ether oil, and a PAG oil.
[0068]
Although the example of the home freezing refrigerator which used the inflammable refrigerant showed in this embodiment, it does not restrict to this, and the same effect is demonstrated even if it is a business-use freezing refrigerator, a freezer for vending machines or a dehumidifier, a home air conditioning machine, and a business-use air conditioning machine.
[0069]
Embodiment 2.
Drawing 2 is other examples of this embodiment of the invention a refrigerant circuit figure of the shown home freezing refrigerator, and for the controller 20 of the electric type expansion valve 3. The signal from the thermo sensitive register 23 which detects the discharge temperature of the compressor 1 is inputted, and based on these signals, it is constituted so that the opening of the electric type expansion valve 3 may be controlled according to the discharge temperature of the compressor 1. As a refrigerant of this freezing refrigerator, although an inflammability is shown, the adverse effect to global warming uses the very small hydrocarbon system refrigerant R600a (isobutane). Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.
[0070]
The discharge temperature of the compressor 1 under compressor operation is detected, and the opening of the electronic formula expansion valve 3 is controlled by this embodiment so that this discharge temperature becomes an optimum value, for example, 90 **. At namely, the time of a value with bigger compressor discharge temperature detected with the thermo sensitive register 23 than 90 **. An opening command is outputted so that the opening of the electric type expansion valve 3 may be made larger than the present, and at the time of the value whose compressor discharge temperature conversely detected with the thermo sensitive register 23 is smaller than 90 **, an opening command is outputted so that the opening of the electric type

expansion valve 3 may be made smaller than the present.
[0071]
In the conventional refrigerator, since the capillary tube which is a fixed diaphragm was used as an collimator, when the discharge temperature of the compressor 1 had a high ambient air temperature on which it changed depending on the service condition of a refrigerator, for example, the refrigerator was put, the discharge temperature of the compressor 1 was also rising. When the discharge temperature of the compressor 1 rose, the refrigerating machine oil in a compressor deteriorates easily, and there was a danger that the reliability of the compressor 1 fell. If the discharge temperature of the compressor 1 rose, it will become easy to generate sludge, and this sludge deposited on piping or a capillary tube, and there was a danger that **** would occur. When the discharge temperature of the compressor 1 furthermore rose, inside the compressor, the compressor inhalation refrigerant was heated, compressor inhalation refrigerant temperature also rose, and there was a danger that the refrigerating capacity fall and energy efficiency fall by decreased density of an inhalation refrigerant would arise.
[0072]
However, since the discharged refrigerant temperature of the compressor 1 is always controlled by the electric type expansion valve 3 at this embodiment also including the time of compressor start in the domestic refrigerator for which the temperature in a warehouse is uniformly controlled by intermittent operation of a compressor to become an optimum value, Even if the air temperature of the circumference in which the refrigerator is installed rises, compressor discharge temperature does not rise beyond an optimum value, and the reliability deterioration of the refrigerator by degradation of refrigerating machine oil or sludge generating can be prevented. Heating of the compressor inhalation refrigerant inside a compressor is not generated, either, but the refrigerator where energy efficiency is high can be provided.
[0073]
According to this embodiment, liquid cooling intermediation can be prevented also from flowing into a compressor at the time of compressor start, etc. Namely, since compressor discharge temperature will fall if liquid cooling intermediation flows into a compressor, In order that the controller 20 may issue instructions by detecting the fall of this compressor discharge temperature so that the opening of the electric type expansion valve 3 may be made small, the liquid cooling intermediation inflow to a compressor is prevented, and neither liquid compression nor the reliability deterioration of the compressor due to the viscosity down of refrigerating machine oil is also generated.
[0074]
Embodiment 3.
Drawing 3 is other examples of this embodiment of the invention a refrigerant circuit figure of the shown home freezing refrigerator, and for the controller 20 of the electric type expansion valve 3. The signal from the thermo sensitive register 23 which detects the outlet refrigerant temperature of the signal from the thermo sensitive register 21 and the evaporator 4 which detects the inlet refrigerant temperatures of the evaporator 4 is inputted, and based on these signals, it is constituted so that the opening of the electric type expansion valve 3 may be controlled according to the refrigerant state of evaporator 4 exit. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.
[0075]
Next, operation of the controller 20 under compressor operation of this embodiment is explained. The inlet refrigerant temperatures T1 of the evaporator 4 detected from the thermo sensitive register 21 and the refrigerant temperature T4 of evaporator 4 exit detected from the thermo sensitive register 24 are inputted into the controller 20, and the degree of superheat of the outlet refrigerant of the evaporator 4 is calculated by this two temperature-gradients T4-T1. And an opening command is outputted to the electric type expansion valve 3 so that this degree-of-superheat T4-T1 may become the proper designed value defined beforehand, for example, 5 **. At namely, the time of a value with a bigger evaporator outlet refrigerant degree of superheat detected with the thermo sensitive registers 21 and 24 than a designed value. An

opening command is outputted so that the opening of the electric type expansion valve 3 may be made larger than the present, and at the time of the value whose evaporator outlet refrigerant degree of superheat conversely detected with the thermo sensitive registers 21 and 24 is smaller than a designed value, an opening command is outputted so that the opening of the electric type expansion valve 3 may be made smaller than the present.

[0076]

Since the capillary tube which is a fixed diaphragm was used with the collimator, depending on the service condition of a refrigerator, an evaporator outlet refrigerant degree of superheat always could not control by the conventional refrigerator to an optimum value at the time of compressor start, etc., but there was a case where an evaporator exit would be in a gas-liquid two phase state, or it will be in the overheated steam state where a degree of superheat is big, in it. Since unevaporated liquid cooling intermediation flows out of an evaporator when an evaporator exit is in a gas-liquid two phase state, refrigerating capacity declines and the energy efficiency of a refrigerator falls. Since the heat-conducting characteristic of an overheated steam refrigerant is worse than a gas-liquid two-phase refrigerant on the other hand when an evaporator exit changes into the overheated steam state where a degree of superheat is big, the heat exchanging efficiency of an evaporator falls and the energy efficiency of a refrigerator falls too.

[0077]

However, since the degree of superheat of the outlet refrigerant of the evaporator 4 is always controlled by the electric type expansion valve 3 at this embodiment also including the time of compressor start in the domestic refrigerator for which the temperature in a warehouse is uniformly controlled by intermittent operation of a compressor to become an optimum value, Unevaporated liquid cooling intermediation cannot flow out of an evaporator, or the heat exchanging efficiency of an evaporator cannot fall, and the energy efficiency of a refrigerator can be raised.

[0078]

Embodiment 4.

Drawing 4 is other examples of this embodiment of the invention a refrigerant circuit figure of the shown home freezing refrigerator, and for the controller 20 of the electric type expansion valve 3. The signal from the thermo sensitive register 26 which detects the outlet refrigerant temperature of the signal from the thermo sensitive register 25 and the condenser 2 which detects the inlet refrigerant temperatures of the electric type expansion valve 3 is inputted, and based on these signals, it is constituted so that the opening of the electric type expansion valve 3 may be controlled according to the refrigerant state of electric type expansion valve 3 exit. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.

[0079]

Next, operation of the controller 20 under compressor operation of this embodiment is explained. The inlet refrigerant temperatures T5 of the electric type expansion valve 3 detected from the thermo sensitive register 25 and the refrigerant temperature T6 of condenser 2 exit detected from the thermo sensitive register 26 are inputted into the controller 20, and the supercooling degree of the entrance refrigerant of the electric type expansion valve 3 is calculated by this two temperature-gradients T6-T5. And an opening command is outputted to the electric type expansion valve 3 so that this supercooling degree T6-T5 may become the proper designed value defined beforehand, for example, 2 **. At namely, the time of a value with a bigger refrigerant supercooling degree of the electric type expansion valve entrance detected with the thermo sensitive registers 25 and 26 than a designed value. An opening command is outputted so that the opening of the electric type expansion valve 3 may be made larger than the present, and at the time of the value whose refrigerant supercooling degree of the electric type expansion valve entrance conversely detected with the thermo sensitive registers 25 and 26 is smaller than a designed value, an opening command is outputted so that the opening of the electric type expansion valve 3 may be made smaller than the present.

[0080]

In the conventional refrigerator, since the capillary tube which is a fixed diaphragm was used with the collimator, depending on the service condition of a refrigerator, the vapor-liquid mixing ratio of the capillary tube entrance changed a lot, the vapor refrigerant increased and liquid cooling intermediation was increasing. If the vapor-liquid mixing ratio of a capillary tube entrance changes, the refrigerant flow rate which passes a capillary tube is also changed, refrigerating capacity will decline or the energy efficiency of a refrigerator will fall. It was, also when the flow pattern of the gas-liquid two-phase refrigerant of a capillary tube inlet section became slug flow and a loud refrigerant flow sound occurred.

[0081]

However, in the domestic refrigerator which is controlling the temperature in a warehouse by this embodiment uniformly by the intermittent operation of a compressor, Since ********** of the entrance refrigerant of the electric type expansion valve 3 is always controlled by the electric type expansion valve 3 also including the time of compressor start to become an optimum value, there is no change of the refrigerant flow rate which passes an electric type expansion valve, and the energy efficiency of a refrigerator can be raised. The refrigerant flow pattern of an electric type expansion valve entrance does not serve as slug flow, and can prevent generating of the refrigerant flow sound in an electric type expansion valve.

[0082]

Embodiment 5.

Drawing 5 is a refrigerant circuit figure of the home freezing refrigerator in which other examples of this embodiment of the invention are shown, the capillary tube 31 is formed upstream of the electronic formula expansion valve 3, and the capillary tube 32 is formed downstream. It is soldered, and the heat recollection heat exchanger 10a is constituted, the capillary tube 32 and the suction piping of the compressor 1 are also soldered, and the capillary tube 31 and the suction piping of the compressor 1 constitute the heat recollection heat exchanger 10b. The signal from the thermo sensitive register 22 which detects the inhalation refrigerant temperature of the signal from the thermo sensitive register 21 and the compressor 1 which detects the inlet refrigerant temperatures of the evaporator 4 is inputted into the controller 20 of the electric type expansion valve 3, It is constituted so that the opening of the electric type expansion valve 3 may be controlled based on these signals to become an optimum value about the inhalation refrigerant degree of superheat of the compressor 1. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.

[0083]

Compared with the embodiment which provided the capillary tube in the upper stream and the lower stream of the electric type expansion valve 3, constituted the collimator from this embodiment, and constituted the collimator only from an electric type expansion valve shown in drawing 1, the danger of generating by foreign matters, such as sludge, got blocked is reduced. That is, according to this embodiment, since sludge deposits also on the capillary tube before and behind an electric type expansion valve, compared with what constituted the collimator only from an electric type expansion valve, the amount of sludge deposited on an electric type expansion valve can be reduced. For this reason, electric type expansion valve **** by sludge can carry out danger reduction, and a reliable refrigerator can be provided.

[0084]

Although this embodiment showed the composition which installs a capillary tube in the upper stream and the lower stream of the electric type expansion valve 3, it does not restrict to this, and the same effect is demonstrated even if it installs a capillary tube only upstream of the electric type expansion valve 3. A capillary tube may be installed only downstream from the electric type expansion valve 3.

[0085]

Embodiment 6.

Drawing 6 is a refrigerant circuit figure of the home freezing refrigerator in which other examples of this embodiment of the invention are shown, and the capillary tube 33 is formed in parallel with the electronic formula expansion valve 3. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.

[0086]
According to this embodiment, since the capillary tube is installed in parallel with the electric type expansion valve 3, compared with the embodiment which constituted the collimator only from an electric type expansion valve shown in drawing 1, the refrigerant flow rate which passes an electric type expansion valve can be reduced, and a small and cheap electric type expansion valve can be used. Compared with what constituted the collimator only from an electric type expansion valve, by installing a capillary tube in parallel, the amount of sludge deposited on an electric type expansion valve can be reduced, electric type expansion valve **** by sludge can carry out danger reduction, and a reliable refrigerator can be provided. Even when an electric type expansion valve blockades with sludge or a foreign matter, since the refrigerant can pass a capillary tube, it should maintain necessary minimum operation and should further provide a reliable refrigerator.
[0087]
Embodiment 7.
Drawing 7 is a refrigerant circuit figure of the home freezing refrigerator in which other examples of this embodiment of the invention are shown, and the inverter 35 with which arbitrary value setting out of the number of rotations can be carried out is connected to the compressor 1. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.
[0088]
According to this embodiment, when number of rotations uses a variable inverter drive compressor as a compressor of the home freezing refrigerator which used the inflammable refrigerant, improvement in energy efficiency is aimed at. Namely, the ambient air temperature in which refrigerators, such as night, were installed is low, and there is almost no door opening close of a refrigerator, and when the heat load of a refrigerator is small. The energy efficiency of a refrigerator can be raised by making the number of rotations of the compressor 1 small with the inverter 31, and operating, where the electrical input of a compressor is made small. Since the refrigerating capacity of a refrigerating cycle decreases and a compressor interruption period can be reduced if the number of rotations of the compressor 1 is decreased, refrigerant movement and the energy loss accompanying the intermittent operation of a compressor can also be reduced, and energy efficiency improves further.
[0089]
As a revolving speed control method of the compressor 1 by the inverter 35, the ambient air temperature in which the refrigerator was installed is detected, and compressor number of rotations is controlled according to this ambient air temperature. Namely, when ambient air temperature is high, it is large, and the heat load of a refrigerator also enlarges compressor number of rotations at this time, and operates it by big refrigerating capacity. When ambient air temperature is low, it is small, and the heat load of a refrigerator also makes compressor number of rotations small at this time, and operates it by small refrigerating capacity. If it controls based on the information on the door opening close of a refrigerator, or temperature inside to adjust compressor number of rotations further in this case, energy efficiency will improve further.
[0090]
As a method of controlling the electric type expansion valve 3 of this embodiment, By controlling like the embodiment shown in drawing 1, so that the inhalation refrigerant degree of superheat of the compressor 1 serves as an optimum value, Even if the number of rotations of the compressor 1 changes, the inhalation refrigerant degree of superheat of the compressor 1 can always control the optimal, and the refrigerator in which the reliability of a compressor is high and energy efficiency is moreover high can be provided. As the control method of this electric type expansion valve 3, it does not restrict to this, and like the embodiment shown in drawing 4 from drawing 2, even if it controls entrance refrigerant the discharge temperature of the compressor 1, the outlet refrigerant degree of superheat of the evaporator 4, or supercooling degree of the electric type expansion valve 3 the optimal, the same effect is demonstrated. The opening of the electric type expansion valve 3 may be controlled from the rotational frequency information of the compressor 1. Namely, by enlarging the opening of the electric type expansion

valve 3, when the number of rotations of the compressor 1 is large, and controlling to make small the opening of the electric type expansion valve 3, when the number of rotations of the compressor 1 is conversely small, The state of a cycle can be controlled the optimal and the refrigerator in which a thermo sensitive register is unnecessary, the reliability of a compressor is high and energy efficiency is moreover high cheaply can be provided.

[0091]

Embodiment 8.

Drawing 8 is the side sectional view and rear elevation of a home freezing refrigerator showing other examples of this embodiment of the invention, and the compressor 1 and the condenser 2, and the fan 40 for heat dissipation are installed in the lower part of the back of a refrigerator. Identical codes are given to the same component parts as what was shown in drawing 1, and the overlapping explanation is omitted.

[0092]

According to this embodiment, the piping 41 which is a part of refrigerant piping which connects the condenser 2 with the compressor 1 is installed into near the fan 40 for heat dissipation (i.e., the flow of the air which the fan 40 for heat dissipation produces). Furthermore, the pressure resistance of this refrigerant piping 41 is designed smaller than refrigerant piping other than this refrigerant piping 41, such as the condenser 2 and the evaporator 4. That is, the refrigerant piping placed near the fan 40 for heat dissipation is a field of static internal pressure intensity or dynamic fatigue strength, and is designed weakliest. Irrespective of under operation of a compressor and a stop, a power supply is always supplied and the fan 40 for heat dissipation forms the flow of air around the refrigerant piping 41.

[0093]

In the conventional domestic refrigerator, the intensity of the refrigerant piping which constitutes a refrigerating cycle was various, and the refrigerant disclosure by the insufficient strength of refrigerant piping had the danger of generating by various parts. If an inflammable refrigerant is especially revealed from the space in a refrigerator warehouse, such as the evaporator 4, and the refrigerant piping which was open for free passage, a possibility that the inside of a warehouse will become explosion concentration will be high, and the danger that an explosion accident will arise will also become high. So, according to this embodiment, the pressure resistance of refrigerator warehouse inner space and the refrigerant piping which is not open for free passage is made the smallest, the inflow of the inflammable refrigerant to warehouse inner space is prevented thoroughly, and the safety of the refrigerator is improved. By installing near the fan for heat dissipation controlled to always operate this refrigerant piping furthermore, Even if an inflammable refrigerant should be revealed from this refrigerant piping 41, according to the air current which the fan 40 for heat dissipation produces, diffused the inflammable refrigerant, it was kept from serving as inflammable concentration, and has prevented the occurrence of an explosion accident.

[0094]

Since the drive motor 40a of the fan 40 for heat dissipation is located in the upstream of the fan for air blasting, even if a refrigerant should begin to leak, it does not ignite to the inflammable refrigerant which began to leak by energization of the motor 40a.

As a means which makes small the internal pressure intensity and fatigue strength of the refrigerant piping 41, piping intensity can be made small making thickness of piping thin, and by using not a tube but an elliptic tube. The material of piping may be changed or weld strength may be weakened.

[0095]

Thus, since the inflammable refrigerant which an inflammable refrigerant did not advance into warehouse inner space, and was moreover revealed is diffused with the fan for heat dissipation in this embodiment even if an inflammable refrigerant should be revealed from a cycle to the exterior by the insufficient strength of refrigerant piping, It does not become inflammable concentration in the refrigerator exterior, either, and the safety of a refrigerator can be improved. Also during a compressor stop, since it is controlling to operate the fan for heat dissipation, even if refrigerant disclosure occurs at the time of a compressor stop, an

inflammable refrigerant can be diffused certainly and the safety of a refrigerator improves further.

[0096]

Embodiment 9.

Drawing 9 is a system configuration figure showing the example which made controllable the refrigerator of the embodiments of the invention 1-8 via the communication line. In this example, the electric light line is used for the communication line in a building.

In drawing 9, the controllers 20 and 50 by which 20 was indicated to the above-mentioned Embodiments 1-7 are the refrigerator bodies indicated to Embodiment 8, and since other composition is the same as each embodiment, they omit explanation.

[0097]

100 is a control base which connects the controller 20 and electric light line of the refrigerator 50, It is connected with the controller 20, the control means (microcomputer) 101 which considers transfer of a control signal as a controller, this control means 101, and an electric light line are connected, and it has the electric light line communication interface 102 which comprises the means of communication 103, strange and a demodulation means 104, and the coupling means 105.

[0098]

200 is a communication controller which connects an electric light line and the ordinary public circuit (telephone line) 300, The electric light line communication interface 201 connected to an electric light line, It has the modem 203 which connects the modem 203 and the microcomputer 203 which are connected with the radio interface 202 and the electric light line communication interface 201 which are connected except electric light lines, such as infrared rays, and the radio interface 202, and the ordinary public circuit 300.

[0099]

From the ordinary public circuit 300, it is connected to a Personal Digital Assistant, an electric power company, a security company, a service company, the manufacturer of a refrigerator, etc. and mutual through an external cellular phone and also an Internet line, and transmission and reception have become possible the controller 20 and mutual. And the information on the refrigerator 50 that it comes into the controller 20 can be collected from the exterior via such a communications system, and the refrigerator 50 can be controlled via the controller 20 from the exterior.

[0100]

Since the controller 20 is supervising the state of the refrigerant the entrance of the compressor 1, an exit, an evaporator exit, or near a flow control valve according to this embodiment, operational status, an abnormal condition, etc. of a refrigerator can be known using the information. If it is made for a drive control command signal to also be known, the abnormal condition of a refrigerator can also be known from control command signals and a refrigerant state. Since it can detect that the inflammable refrigerant leaked from operational status etc. and this can be known from the outside, operation of a refrigerator (compressor) can be promptly suspended by the remote control from the outside, or energization of other electrical household appliances and electrical equipment similarly connected to the communications system can be stopped.

[0101]

A manufacturer and a service company are able to do from the exterior the setting variation of the preset value of the compressor inhalation degree of superheat mentioned above, the preset value of the discharge temperature of a compressor, the preset value of an evaporator outlet refrigerant degree of superheat, the preset value of the refrigerant supercooling degree of an electrical machinery type expansion valve entrance, etc. according to an operation condition, aging of ambient environment and apparatus, etc. Since thermo sensitive registers to supervise can use the thermo sensitive register used by the embodiment mentioned above as it is and the increase in part mark can be suppressed compared with the increase in a function, it excels also in the demolition nature in the time of recycling, etc.

[Brief Description of the Drawings]

[0102]
[Drawing 1]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 1 is shown.
[Drawing 2]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 2 is shown.
[Drawing 3]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 3 is shown.
[Drawing 4]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 4 is shown.
[Drawing 5]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 5 is shown.
[Drawing 6]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 6 is shown.
[Drawing 7]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 7 is shown.
[Drawing 8]The side sectional view and rear elevation of a domestic refrigerator showing this embodiment of the invention 8.
[Drawing 9]The system configuration figure showing the communications system of the domestic refrigerator in which this embodiment of the invention 9 is shown.
[Drawing 10]The refrigerant circuit figure of the conventional domestic refrigerator.
[Drawing 11]The characteristic figure showing operation of the conventional domestic refrigerator
[Description of Notations]
[0103]
1 A compressor and 2 A condenser and 3 An electronic formula expansion valve and 4 An evaporator and 10 A heat recollection heat exchange mechanism, 20 controllers, and 21 A thermo sensitive register and 22 A thermo sensitive register and 31 A capillary tube and 32 A capillary tube and 33 A capillary tube and 35 An inverter and 40 Fan for heat dissipation.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[0102]
[Drawing 1]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 1 is shown.
[Drawing 2]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 2 is shown.
[Drawing 3]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 3 is shown.
[Drawing 4]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 4 is shown.
[Drawing 5]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 5 is shown.
[Drawing 6]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 6 is shown.
[Drawing 7]The refrigerant circuit figure of the domestic refrigerator in which this embodiment of the invention 7 is shown.
[Drawing 8]The side sectional view and rear elevation of a domestic refrigerator showing this embodiment of the invention 8.
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[Drawing 10]The refrigerant circuit figure of the conventional domestic refrigerator.
[Drawing 11]The characteristic figure showing operation of the conventional domestic refrigerator

[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-12127
(P2004-12127A)
(43)公開日　平成16年1月15日(2004.1.15)

(51)Int.Cl.[7]	F I			テーマコード（参考）
F25D 19/00	F25D	19/00	510Z	3L045
F25B 1/00	F25B	1/00	304C	
F25D 11/00	F25B	1/00	304H	
	F25B	1/00	304P	
	F25B	1/00	331Z	

審査請求 有　請求項の数 22　OL　（全 20 頁）　最終頁に続く

(21)出願番号　特願2003-344079(P2003-344079)
(22)出願日　平成15年10月2日(2003.10.2)
(62)分割の表示　特願2000-49227(P2000-49227)の分割
原出願日　平成12年2月25日(2000.2.25)

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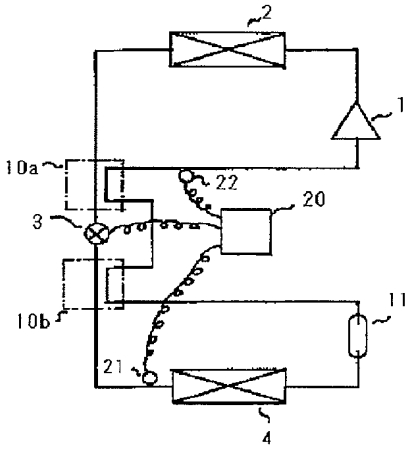
Fターム(参考)　3L045 AA02 BA01 CA02 DA02 JA12 LA12 LA17 MA01 NA01 NA09 PA02 PA05

(54)【発明の名称】可燃性冷媒を用いた冷蔵庫

(57)【要約】
【課題】地球環境に対する悪影響の非常に小さい可燃性冷媒を用いた冷凍空調装置において、機器のエネルギー効率を向上させ、しかも冷媒漏洩時の安全性を高める。
【解決手段】　圧縮機１、凝縮器２、絞り装置３、蒸発器４を、冷媒として可燃性冷媒を用いて流通させる冷媒配管により順次連結してなる冷凍サイクルにおいて、絞り装置を連続的に開度調整可能な流量制御弁で構成し、圧縮機入口の冷媒状態を検知して流量制御弁の弁開度を制御した。
【選択図】　図１



１．　圧縮機
２．　凝縮器
３．　電気式膨張弁（流量制御弁）
４．　蒸発器
１０ａ、１０ｂ．　熱回収熱交換器
１１．　ヘッダー
２０．　コントローラ（制御手段）
２１、２２．　サーミスタ

【特許請求の範囲】
【請求項１】
圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記絞り装置を開度調整可能な流量制御弁で構成し、かつ、前記凝縮器の出口側と前記蒸発器の入口側との間に、前記凝縮器を出た前記可燃性冷媒を前記圧縮機の吸入冷媒により冷却する熱回収熱交換器を設けたことを特徴とする冷蔵庫。
【請求項２】
前記熱回収熱交換器を、前記凝縮器の出口側と前記液流制御弁の入口側との間に設けたことを特徴とする請求項１に記載の冷蔵庫。
【請求項３】
前記熱回収熱交換器を、前記液流制御弁の出口側と前記蒸発器の入口側との間に設けたことを特徴とする請求項１に記載の冷蔵庫。
【請求項４】
圧縮機入口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたことを特徴とする請求項１～請求項３のいずれかに記載の冷蔵庫。
【請求項５】
前記検知手段を圧縮機の吸入過熱度検知手段とし、前記制御手段は、この吸入過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、吸入過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御することを特徴とする請求項４記載の冷蔵庫。
【請求項６】
圧縮機出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたことを特徴とする請求項１～請求項３のいずれかに記載の冷蔵庫。
【請求項７】
前記検知手段を圧縮機の吐出温度検知手段とし、前記制御手段は、この吐出温度が所定の温度よりも大きな値のときは、流量制御弁の開度を大きくし、吐出温度が前記所定の温度よりも小さな値のときは、流量制御弁の開度を小さくするよう制御することを特徴とする請求項６記載の冷蔵庫。
【請求項８】
蒸発器出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたことを特徴とする請求項１～請求項３のいずれかに記載の冷蔵庫。
【請求項９】
前記検知手段を蒸発器の出口冷媒過熱度検知手段とし、前記制御手段は、この出口冷媒過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、出口冷媒過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御することを特徴とする請求項８記載の冷蔵庫。
【請求項１０】
流量制御弁の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたことを特徴とする請求項１～請求項３のいずれかに記載の冷蔵庫。
【請求項１１】
前記検知手段を流量制御弁の冷媒過冷却度検知手段とし、前記制御手段は、この冷媒過冷却度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、冷媒過冷却度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御することを特徴とする請求項１０記載の冷蔵庫。
【請求項１２】

圧縮機停止時に、流量制御弁の弁開度を全閉とするように制御する制御手段を備えたことを特徴とする請求項１～請求項８のいずれかに記載の冷蔵庫。
【請求項１３】
冷凍サイクルからの冷媒漏洩を検知する漏洩検知手段と、前記漏洩検知手段によって冷媒漏洩を検知した時に、流量制御弁の弁開度を全閉とするように制御する制御手段とを備えたことを特徴とする請求項１～請求項８のいずれかに記載の冷蔵庫。
【請求項１４】
流量制御弁の上流あるいは下流に毛細管を設けたことを特徴とする請求項１～請求項８のいずれかに記載の冷蔵庫。
【請求項１５】
流量制御弁と並列に毛細管を設けたことを特徴とする請求項１～請求項８のいずれかに記載の冷蔵庫。
【請求項１６】
圧縮機を回転数可変のインバータ駆動としたことを特徴とする請求項１～請求項１５のいずれかに記載の冷蔵庫。
【請求項１７】
圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記圧縮機を回転数可変のインバータ駆動とし、かつ、前記凝縮器の出口側と前記蒸発器の入口側との間に、前記凝縮器を出た前記可燃性冷媒を前記圧縮機の吸入冷媒により冷却する熱回収熱交換器を設けたことを特徴とする冷蔵庫。
【請求項１８】
冷蔵庫の負荷を検知する負荷検知手段と、前記負荷検知手段によって検知した負荷に応じて、圧縮機の回転数を制御する制御手段とを備えたことを特徴とする請求項１７に記載の冷蔵庫。
【請求項１９】
冷蔵庫の庫外温度を検知する庫外温度検知手段と、前記庫外温度検知手段によって検知した庫外温度に応じて、圧縮機の回転数を制御する制御手段とを備えたことを特徴とする請求項１７に記載の冷蔵庫。
【請求項２０】
冷蔵庫の庫内温度を検知する庫内温度検知手段と、前記庫内温度検知手段によって検知した庫内温度に応じて、圧縮機の回転数を制御する制御手段とを備えたことを特徴とする請求項１７に記載の冷蔵庫。
【請求項２１】
圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記圧縮機を回転数可変のインバータ駆動とするとともに、前記絞り装置を開度調整可能な流量制御弁で構成し、かつ、前記凝縮器の出口側と前記蒸発器の入口側との間に、前記凝縮器を出た前記可燃性冷媒を前記圧縮機の吸入冷媒により冷却する熱回収熱交換器を設けたことを特徴とする冷蔵庫。
【請求項２２】
圧縮機の回転数を検知する回転数検知手段と、前記回転数検知手段によって検知された圧縮機回転数に応じて、流量制御弁の弁開度を制御する制御手段とを備えたことを特徴とする請求項２１に記載の冷蔵庫。
【発明の詳細な説明】
【技術分野】
【０００１】
この発明は、オゾン層破壊や地球温暖化などの地球環境に悪影響を与えることのない冷媒を用いた冷蔵庫に関するものである。
【背景技術】
【０００２】

現在、冷凍冷蔵庫の冷媒には、フロン系の冷媒が用いられている。フロン系冷媒のなかでもＣＦＣ系およびＨＣＦＣ系冷媒は、大気へ放出された場合、オゾン層を破壊するため、ＨＦＣ系フロン冷媒への移行が進められている。家庭用冷凍冷蔵庫では、ＨＦＣ系冷媒であるＲ１３４ａが広く用いられている。

【０００３】

図１０は家庭用冷蔵庫の冷媒回路構成を示す図であり、図において１は圧縮機、２は凝縮器、３は絞り装置である毛細管、４は蒸発器である。また毛細管３と圧縮機１の吸入配管は半田付けされており、熱回収熱交換器１０を構成している。さらに蒸発器４の出口側配管には、負荷変化時などに発生する余剰冷媒を溜めるヘッダー１１が設けられている。また４０は放熱用送風機であり、圧縮機１運転中は放熱用送風機４０も運転し、圧縮機１停止中は放熱用送風機４０も停止するように制御されている。

【０００４】

次に、この従来のフロン系冷媒を用いた家庭用冷凍冷蔵庫の動作について、図１１に示した圧力－エンタルピー線図を用いて説明する。圧縮機１を出た高温高圧の冷媒蒸気は（図中Ａ点）、凝縮器２に流入し、外気などで冷却され気液二相状態まで凝縮する（図中Ｂ点）。凝縮器２を出た気液二相冷媒は、毛細管３に流入し減圧され、低圧の気液二相冷媒となる。毛細管３は圧縮機１の吸入配管と熱回収熱交換器１０を構成しているので、毛細管３を通る冷媒は、圧縮機１の吸入配管によって冷却される（図中Ｃ点）。この低圧の気液二相冷媒は蒸発器４に流入し、冷蔵庫庫内を冷却して、低圧の飽和蒸気状態となって蒸発器４を流出する（図中Ｄ点）。この低圧の蒸気冷媒は、ヘッダー１１を経て熱回収熱交換器１０に流入し、毛細管３を通る冷媒によって加熱され、低圧の過熱蒸気となって、再び圧縮機１に吸入される（図中Ｅ点）。

【０００５】

しかしこのＨＦＣ系冷媒は、大気放出された場合、地球温暖化を促進する物質であり、地球環境を亟化させない炭化水素冷媒やアンモニアなどの自然冷媒を冷蔵庫の冷媒として用いることが検討されている。この可燃性冷媒を用いた冷蔵庫としては、例えば特開平８－１７８４８１号公報に示されたものがある。この冷凍冷蔵庫の冷媒としては、地球温暖化に対する影響は非常に小さいが、可燃性を示すプロパンやブタン等の炭化水素系冷媒が用いられている。またこの冷凍冷蔵庫の冷媒配管接続部の近傍には、可燃性冷媒検知センサが設置されている。

【０００６】

冷凍サイクルの配管接続部などから、可燃性冷媒が漏洩した場合には、可燃性冷媒検知センサがこれを検知し、圧縮機１に停止信号を送信するように制御されており、万一可燃性冷媒が漏洩しても爆発につながることが無いように制御されている。

【特許文献１】特開平８－１７８４８１号公報

【発明の開示】

【発明が解決しようとする課題】

【０００７】

上記のような従来の冷蔵庫では、地球温暖化を抑制するために地球温暖化に対する影響の非常に小さい炭化水素系冷媒を冷蔵庫の冷媒として用いている。しかし地球温暖化を抑制するためには、冷媒自身の地球温暖化だけではなく、冷蔵庫の電力使用による地球温暖化を抑制することも重要である。すなわち冷蔵庫のエネルギー効率を向上させることも重要な課題となる。

【０００８】

また家庭用冷蔵庫は、外気温度変化など冷蔵庫の負荷が変化しても庫内温度を一定に制御するため、圧縮機は断続運転を行なっており、この圧縮機断続運転による エネルギー損失を小さくすることが、冷蔵庫のエネルギー効率向上に重要となる。

【０００９】

さらに可燃性冷媒使用時の安全性を高めるためには、圧縮機への液バックを防止したり、圧縮機吐出温度を適正に制御して圧縮機の信頼性を向上させたり、絞り部に異物などが

詰まることによる閉塞を防止し、冷凍サイクルの信頼性を向上させることが重要である。すなわち可燃性冷媒を用いた冷蔵庫の市場での部品交換時などによる可燃性冷媒の漏洩による着火事故を未然に防止して、冷蔵庫の安全性をより一層向上させる必要がある。さらに冷蔵庫に充填される冷媒量を削減したり、機器からの冷媒漏洩を抑制したり、あるいは万一の冷媒漏洩が生じた際には、可燃濃度とならないように早期に冷媒を拡散させることが重要である。

【００１０】

この発明は、上記のような問題を解決するためになされたもので、地球環境に対する悪影響の非常に小さい可燃性冷媒を用いた冷蔵庫において、機器のエネルギー効率を向上させ、しかも安全性および信頼性を高めた冷蔵庫に関するものである。

【課題を解決するための手段】

【００１１】

この発明に係る冷蔵庫は、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記絞り装置を開度調整可能な流量制御弁で構成したものである。

【００１２】

また、圧縮機入口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたものである。

【００１３】

また、前記検知手段を圧縮機の吸入過熱度検知手段とし、前記制御手段は、この吸入過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、吸入過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するものである。

【００１４】

また、圧縮機出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたものである。

【００１５】

また、前記検知手段を圧縮機の吐出温度検知手段とし、前記制御手段は、この吐出温度が所定の温度よりも大きな値のときは、流量制御弁の開度を大きくし、吐出温度が前記所定の温度よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するものである。

【００１６】

また、蒸発器出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたものである。

【００１７】

また、前記検知手段を蒸発器の出口冷媒過熱度検知手段とし、前記制御手段は、この出口冷媒過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、出口冷媒過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するものである。

【００１８】

また、流量制御弁の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたものである。

【００１９】

また、前記検知手段を流量制御弁の冷媒過冷却度検知手段とし、前記制御手段は、この冷媒過冷却度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、冷媒過冷却度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するものである。

【００２０】

また、圧縮機停止時に、流量制御弁の弁開度を全閉とするように制御する制御手段を備えたものである。

【００２１】
また、冷凍サイクルからの冷媒漏洩を検知する漏洩検知手段と、前記漏洩検知手段によって冷媒漏洩を検知した時に、流量制御弁の弁開度を全閉とするように制御する制御手段とを備えたものである。
【００２２】
また、流量制御弁の上流あるいは下流に毛細管を設けたものである。
【００２３】
また、流量制御弁と並列に毛細管を設けたものである。
【００２４】
また、圧縮機を回転数可変のインバータ駆動としたものである。
【００２５】
また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記圧縮機を回転数可変のインバータ駆動としたものである。
【００２６】
また、冷蔵庫の負荷を検知する負荷検知手段と、前記負荷検知手段によって検知した負荷に応じて、圧縮機の回転数を制御する制御手段とを備えたものである。
【００２７】
また、冷蔵庫の庫外温度を検知する庫外温度検知手段と、前記庫外温度検知手段によって検知した庫外温度に応じて、圧縮機の回転数を制御する制御手段とを備えたものである。
【００２８】
また、冷蔵庫の庫内温度を検知する庫内温度検知手段と、前記庫内温度検知手段によって検知した庫内温度に応じて、圧縮機の回転数を制御する制御手段とを備えたものである。
【００２９】
また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記圧縮機を回転数可変のインバータ駆動とすると共に、前記絞り装置を開度調整可能な流量制御弁で構成したものである。
【００３０】
また、圧縮機の回転数を検知する回転数検知手段と、前記回転数検知手段によって検知された圧縮機回転数に応じて、流量制御弁の弁開度を制御する制御手段とを備えたものである。
【００３１】
また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルと、放熱用送風機とを備え、前記放熱用送風機近傍の冷媒配管の強度をそれ以外の冷媒配管強度よりも弱くしたものである。
【００３２】
また、圧縮機停止中に放熱用送風機を運転するものである。
【発明の効果】
【００３３】
以上説明したとおりこの発明によれば、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、前記絞り装置を開度調整可能な流量制御弁で構成したものであるので、エネルギー効率が高く、しかも圧縮機の信頼性の高い冷蔵庫を提供することができる。
【００３４】
また、圧縮機入口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたので、圧縮機への液冷媒の流入を確実に防止でき、圧縮機の信頼性向上および冷蔵庫の信頼性向上を図ることができる。また冷媒充填量が少なく、さらにエネルギー効率の高い冷蔵庫を提供することができる。

【００３５】
また、前記検知手段を圧縮機の吸入過熱度検知手段とし、前記制御手段は、この吸入過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、吸入過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するので、圧縮機の吸入冷媒過熱度を適切に維持することができる。
【００３６】
また、圧縮機出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたので、冷凍機油の劣化や粘度低下による圧縮機の信頼性低下を防止することができる。さらにスラッジによる配管詰りを防止できると共に、エネルギー効率の高い冷蔵庫を得ることが出来る。
【００３７】
また、前記検知手段を圧縮機の吐出温度検知手段とし、前記制御手段は、この吐出温度が所定の温度よりも大きな値のときは、流量制御弁の開度を大きくし、吐出温度が前記所定の温度よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するので、圧縮機の吐出冷媒温度を適切に維持することができる。
【００３８】
また、蒸発器出口の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたので、未蒸発の液冷媒が蒸発器から流出したり、蒸発器の熱交換効率の低下を防止でき、エネルギー効率の高い冷蔵庫を実現することができる。
【００３９】
また、前記検知手段を蒸発器の出口冷媒過熱度検知手段とし、前記制御手段は、この出口冷媒過熱度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、出口冷媒過熱度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するので、蒸発器の出口冷媒の過熱度を適切に維持することができる。
【００４０】
また、流量制御弁の冷媒状態を検知する検知手段と、前記検知された冷媒状態に基づいて流量制御弁の弁開度を制御する制御手段とを備えたので、冷媒流量の変動がなくエネルギー効率が高く、冷媒流動音の発生のない冷蔵庫を提供することができる。
【００４１】
また、前記検知手段を流量制御弁の冷媒過冷却度検知手段とし、前記制御手段は、この冷媒過冷却度が設計値よりも大きな値のときは、流量制御弁の開度を大きくし、冷媒過冷却度が前記設計値よりも小さな値のときは、流量制御弁の開度を小さくするよう制御するので、流量制御弁の入口冷媒の過冷却度を適切に維持することができる。
【００４２】
また、圧縮機停止時に、流量制御弁の弁開度を全閉とするように制御したものであるので、圧縮機断続運転時のエネルギー損失が低減され、エネルギー効率の高い冷蔵庫を実現することができる。
【００４３】
また、冷凍サイクルからの冷媒漏洩を検知した時に、流量制御弁の弁開度を全閉とするように制御したものであるので、冷媒漏洩量を削減でき、安全性の高い冷蔵庫を得ることができる。
【００４４】
また、流量制御弁の上流あるいは下流に毛細管を設けたものであるので、スラッジによる流量制御弁の詰りを防止し、信頼性の高い冷蔵庫を提供することができる。
【００４５】
また、流量制御弁と並列に毛細管を設けたものであるので、小形安価な流量制御弁を用いることができ、しかもスラッジによる流量制御弁の詰りを防止し、信頼性の高い冷蔵庫を提供することができる。
【００４６】

また、圧縮機を回転数可変のインバータ駆動としたものであるので、圧縮機回転数変化時のサイクル状態を最適に制御でき、エネルギー効率の高い冷蔵庫を提供することができる。

【００４７】

また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、圧縮機を回転数可変のインバータ駆動としたものであるので、エネルギー効率の高い冷蔵庫を提供することができる。

【００４８】

また、冷蔵庫の負荷を検知し、この負荷に応じて、圧縮機の回転数を制御したものであるので、冷蔵庫の負荷が変化しても、常にエネルギー効率の高い状態で冷蔵庫を運転することができる。

【００４９】

また、冷蔵庫の庫外温度を検知し、この庫外温度に応じて、圧縮機の回転数を制御したものであるので、庫外温度が変化しても、常にエネルギー効率の高い状態で冷蔵庫を運転することができる。

【００５０】

また、冷蔵庫の庫内温度を検知し、この庫内温度に応じて、圧縮機の回転数を制御したものであるので、庫内温度が変化しても、常にエネルギー効率の高い状態で冷蔵庫を運転することができる。

【００５１】

また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルを備え、圧縮機を回転数可変のインバータ駆動とすると共に、絞り装置を連続的に開度調整可能な流量制御弁で構成したものであるので、負荷に応じて圧縮機の入力を低減でき、しかも圧縮機回転数変化時のサイクル状態を最適に制御できるため、エネルギー効率が高く、信頼性も高い冷蔵庫を提供することができる。

【００５２】

また、圧縮機の回転数を検知し、この圧縮機回転数に応じて、流量制御弁の弁開度を制御したものであるので、安価で、信頼性が高く、しかもエネルギー効率の高い冷蔵庫を得ることができる。

【００５３】

また、圧縮機、凝縮器、絞り装置、蒸発器を冷媒配管により順次連結し、冷媒として可燃性冷媒を流通させる冷凍サイクルと、放熱用送風機とを備え、放熱用送風機近傍の冷媒配管の強度をそれ以外の冷媒配管強度よりも弱くしたものであるので、冷媒漏洩時の安全性を大幅に向上させることができる。

【００５４】

また、圧縮機停止中に放熱用送風機を運転するので、圧縮機停止時の冷媒漏洩に対しても安全性を大幅に向上させることができる。

【発明を実施するための最良の形態】

【００５５】

実施の形態１.

図１はこの発明の実施の形態の一例を示す家庭用冷凍冷蔵庫の冷媒回路図で、従来装置と同様の部分は同一符号で示している。図において、１は圧縮機、２は凝縮器、３は流量制御弁である電気式膨張弁であり、ステッピングモータで駆動され、外部からの電気信号によりその開度を任意に調整することができる、４は蒸発器である。またこの冷凍冷蔵庫の冷媒としては、可燃性を示すものの、地球温暖化への悪影響が非常に小さい炭化水素系冷媒Ｒ６００ａ（イソブタン）を用いている。

【００５６】

また電気式膨張弁３の上流の配管と圧縮機１の吸入配管は半田付けされており、熱回収熱交換器１０ａを構成している。さらに電気式膨張弁３の下流の配管と圧縮機１の吸入配管は半田付けされており、熱回収熱交換器１０ｂを構成している。２０は電気式膨張弁３

のコントローラであり、蒸発器４の入口温度を検知するサーミスタ２１と圧縮機１の吸入温度を検知するサーミスタ２２からの信号が入力され、これらの信号を基に、電気式膨張弁３へ開度指令を出力する。

【００５７】

次に動作について説明する。家庭用冷凍冷蔵庫は、基本的には圧縮機の断続運転によって、冷蔵庫庫内の温度を一定に制御している。そこでここではまず圧縮機が運転中の動作について説明する。圧縮機運転時は、圧縮機１を出た高温高圧の冷媒蒸気は、凝縮器２に流入し、外気などで冷却され気液二相状態まで凝縮する。凝縮器２を出た気液二相冷媒は、熱回収熱交換器１０ａで圧縮機１の吸入冷媒により冷却され、電気式膨張弁３に流入し減圧され、熱回収熱交換器１０ｂでさらに冷却され、低圧の気液二相冷媒となる。この低圧の気液二相冷媒は蒸発器４に流入し、冷蔵庫庫内を冷却して蒸発器４を流出する。この流出した低圧の蒸気冷媒は、熱回収熱交換器１０ｂおよび１０ａに流入し、電気式膨張弁の下流および上流の冷媒によって加熱され、低圧の過熱蒸気となって、再び圧縮機１に吸入される。一方、圧縮機停止中は、電気式膨張弁３を全閉状態としている。このため、凝縮器２内などサイクルの高圧側に存在する冷媒は、蒸発器４内などのサイクルの低圧側へ移動せず、圧縮機運転中の冷媒分布を保持している。

【００５８】

次に圧縮機運転中のコントローラ２０の動作について説明する。コントローラ２０には、サーミスタ２１より検出された蒸発器４の入口冷媒温度Ｔ１とサーミスタ２２より検出された圧縮機１の吸入冷媒温度Ｔ２が入力され、この２つの温度差Ｔ２－Ｔ１により圧縮機１の吸入冷媒の過熱度を演算する。そしてこの過熱度Ｔ２－Ｔ１が予め定められた適正な設計値、例えば５０℃となるように電気式膨張弁３へ開度指令を出力する。すなわちサーミスタ２１、２２によって検知した圧縮機吸入過熱度が設計値よりも大きな値の時は、電気式膨張弁３の開度を現在よりも大きくするように開度指令を出力し、逆にサーミスタ２１、２２によって検知した圧縮機吸入過熱度が設計値よりも小さな値の時は、電気式膨張弁３の開度を現在よりも小さくするように開度指令を出力する。

【００５９】

従来の冷蔵庫では、固定絞りである毛細管が絞り装置と用いられていたため、冷蔵庫の使用条件によっては、圧縮機起動時などに圧縮機吸入冷媒過熱度が常に最適値に制御できず、液冷媒が圧縮機に流入し、液圧縮や圧縮機内の潤滑油の粘度低下などにより圧縮機の信頼性が低下する課題があった。しかし本実施の形態では、圧縮機の断続運転により庫内の温度を一定に制御している家庭用冷蔵庫において、圧縮機起動時も含めて常に圧縮機１の吸入冷媒状態が最適値となるように電気式膨張弁３で制御しているので、圧縮機への液冷媒の流入を確実に防止でき、圧縮機の信頼性向上、すなわち冷蔵庫の信頼性向上を図ることが出来る。また蒸発器出口の冷媒状態を伝熱特性の高い飽和蒸気状態に維持できるので、蒸発器の熱交換特性も常に良好な状態に制御でき、冷蔵庫のエネルギー効率を向上させることが出来る。また不要な液冷媒を削減できるため、サイクル内の冷媒充填量が削減でき、万一の冷媒漏洩時の危険性を小さくすることができる。

【００６０】

またこの実施の形態では、冷蔵庫庫内温度が適正な温度に達し、圧縮機１が停止している時には、電子式膨張弁３を全閉とし、サイクルの高圧側から低圧側への冷媒移動を防止するようにコントローラが制御している。圧縮機の断続運転によって冷蔵庫庫内を一定の温度に制御している家庭用冷凍冷蔵庫では、圧縮機停止時に高圧部から低圧部に冷媒が移動すると、冷蔵庫の工ネルギー効率が低下する。これは圧縮機停止時の冷媒移動により、蒸発器が暖められたり、高圧部の冷媒量が少なくなり、圧縮機再起動時に冷媒不足状態となって効率の悪い運転状態がしばらく続くためである。

【００６１】

炭化水素系冷媒はフロン系冷媒に比べてノズル（例えば図１の電子式膨張弁３内の狭部分）などの流動抵抗の大きな部分を通る流量は増加する傾向を示す。したがって従来のフロン系冷媒を用いた冷蔵庫では、毛細管や圧縮機１の流動抵抗が高圧部と低圧部の冷媒移

動を抑制していたが、炭化水素系冷媒を用いた場合では、毛細管や圧縮機の流動抵抗では十分ではなく、高圧部から低圧部の冷媒移動量は、フロン系冷媒よりも増加する。

【００６２】

ノズルを通る気体の体積流量Ｇは

$$G = V * F * \{2/(\kappa+1)\}^{(1/(\kappa-1))} * [*\{\kappa/(\kappa+1)\} * (P/V)]^{0.5} \quad \cdots \quad (式1)$$

で求められる。ここでＦはノズル断面積、κは比熱比、Ｐは高圧、Ｖは比容積である。この式を用いて、炭化水素系冷媒Ｒ６００αとフロン系冷媒Ｒ１３４αの高圧部から低圧部の移動冷媒流量を計算する。冷蔵庫の圧縮機停止直後の凝縮温度を３０℃、蒸発温度を－３０℃とすると、Ｒ６００αの物性値は、κ＝１．１３８、Ｐ＝４０４ｋＰα、Ｖ＝０．０９５６１ｍ３／ｋｇであり、Ｒ１３４αの物性値は、κ＝１．１９８、Ｐ＝７７０ｋＰα、Ｖ＝０．０２６６７ｍ３／ｋｇとなる。これらの物性値を上式に代入し、Ｒ６００αとＲ１３４αの同一ノズル断面積での移動冷媒流量を求めると、

Ｇ６００α／Ｇ１３４α＝１．２２

となる。すなわちＲ６００αの高圧部から低圧部への移動冷媒流量は、Ｒ１３４αよりも２２％大きくなり、この分Ｒ６００αを用いた冷蔵庫のエネルギー効率はＲ１３４αよりも低下する。

【００６３】

そこで本実施の形態では、このＲ６００αを用いた冷蔵庫の圧縮機停止時の高圧部から低圧部への冷媒移動を防止するために、圧縮機停止時に電子式膨張弁８を全閉に制御している。この結果、圧縮機停止時の高圧部から低圧部への冷媒移動による冷蔵庫のエネルギー効率の低下は防止され、エネルギー効率の高い可燃性冷媒を用いた冷凍冷蔵庫を提供することができる。なお、本実施の形態では、圧縮機停止時に電気式膨張弁を全閉に制御する例について示したが、冷蔵庫内部に冷媒漏洩検知器を設け、冷媒漏洩を検知した時にも、電子式膨張弁を全閉にするように制御すれば、万一冷媒漏洩が発生した場合でも、冷媒漏洩量を少なくでき、冷蔵庫の安全性を一層高めることが出来る。

【００６４】

なお、本実施の形態では、電気信号により開度を任意に調整できる電子式膨張弁を絞り装置として用いる例について説明したが、これに限るものではなく、機械的に開度を調整する温度式膨張弁でも良い。また本実施の形態では、圧縮機吸入冷媒の過熱度を最適値に制御する例について示したが、圧縮機の吸入温度そのものを最適値、例えば３０℃に制御しても良い。

【００６５】

また本実施の形態では、電気式膨張弁８の上流および下流の配管と圧縮機１の吸入配管により熱回収熱交換器１０ａ、１０ｂを構成し、蒸発器出口から圧縮機吸入までの冷媒のエンタルピーを回収し、サイクルのエネルギー効率を向上させている。この実施の形態では熱回収熱交換器を電気式膨張弁８の上流および下流の配管と圧縮機１の吸入配管により構成した例について示したが、これに限ることはなく、電気式膨張弁８の上流配管と圧縮機吸入配管のみで熱回収熱交換器を構成しても同様の効果を発揮する。また電気式膨張弁８の下流配管と圧縮機吸入配管のみで熱回収熱交換器を構成しても良い。

【００６６】

また本実施の形態では、冷媒として可燃性を有する炭化水素冷媒イソブタン（Ｒ６００α）を用いた場合について説明したがこれに限ることは無く、ブタン（Ｒ６００）やプロパン（Ｒ２９０）などの炭化水素冷媒やアンモニアなどの自然冷媒、あるいはこれらの混合冷媒であってもよい。またＲ３２やＲ１５２αなど、地球温暖化係数の小さなＨＦＣ系フロン冷媒、あるいはその混合冷媒であってもよい。

【００６７】

また本実施の形態では、冷凍機油については特に明示していないが、鉱油やアルキルベンゼン、エステル油、エーテル油、ＰＡＧ油などの合成油であっても良い。

【００６８】

また本実施の形態では、可燃性冷媒を用いた家庭用冷凍冷蔵庫の例で示したが、これに限ることはなく、業務用冷凍冷蔵庫や自動販売機用冷凍機、あるいは除湿機、家庭用空調機、業務用空調機であっても同様の効果を発揮する。

【００６９】

実施の形態２.

図２はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、電気式膨張弁８のコントローラ２０には、圧縮機１の吐出温度を検知するサーミスタ２３からの信号が入力され、これらの信号を基に、圧縮機１の吐出温度に応じて電気式膨張弁８の開度を制御するように構成されている。この冷凍冷蔵庫の冷媒としては、可燃性を示すものの、地球温暖化への悪影響が非常に小さい炭化水素系冷媒Ｒ６００ａ（イソブタン）を用いている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００７０】

本実施の形態では、圧縮機運転中の圧縮機１の吐出温度を検知し、この吐出温度が最適値、例えば９０℃となるように電子式膨張弁８の開度を制御している。すなわちサーミスタ２３によって検知した圧縮機吐出温度が９０℃よりも大きな値の時は、電気式膨張弁８の開度を現在よりも大きくするように開度指令を出力し、逆にサーミスタ２３によって検知した圧縮機吐出温度が９０℃よりも小さな値の時は、電気式膨張弁８の開度を現在よりも小さくするように開度指令を出力する。

【００７１】

従来の冷蔵庫では、固定絞りである毛細管が絞り装置として用いられていたため、冷蔵庫の使用条件によっては、圧縮機１の吐出温度は変化し、例えば冷蔵庫が置かれた周囲空気温度が高い場合には、圧縮機１の吐出温度も上昇していた。圧縮機１の吐出温度が上昇すると、圧縮機内の冷凍機油が劣化しやすくなり、圧縮機１の信頼性が低下する危険性があった。また圧縮機１の吐出温度が上昇するとスラッジが発生しやすくなり、配管や毛細管にこのスラッジが堆積し、詰りが発生する危険性もあった。さらに圧縮機１の吐出温度が上昇すると、圧縮機内部で、圧縮機吸入冷媒が加熱され、圧縮機吸入冷媒温度も上昇し、吸入冷媒の密度減少による冷凍能力低下やエネルギー効率低下が生じる危険性があった。

【００７２】

しかし本実施の形態では、圧縮機の断続運転により庫内の温度を一定に制御している家庭用冷蔵庫において、圧縮機起動時も含めて常に圧縮機１の吐出冷媒温度を最適値となるように電気式膨張弁８で制御しているので、冷蔵庫が設置されている周囲の空気温度が上昇しても、圧縮機吐出温度が最適値以上に上昇することはなく、冷凍機油の劣化やスラッジ発生による冷蔵庫の信頼性低下を防止することが出来る。また圧縮機内部での圧縮機吸入冷媒の加熱も発生せず、エネルギー効率の高い冷蔵庫を提供することが出来る。

【００７３】

また本実施の形態では、圧縮機起動時などに液冷媒が圧縮機に流入することも防止できる。すなわち液冷媒が圧縮機に流入すると、圧縮機吐出温度は低下するため、この圧縮機吐出温度の低下を検知することにより、コントローラ２０は電気式膨張弁８の開度を小さくするように指令を出すため、圧縮機への液冷媒流入が防止され、液圧縮や冷凍機油の粘度低下による圧縮機の信頼性低下も発生することはない。

【００７４】

実施の形態３.

図３はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、電気式膨張弁８のコントローラ２０には、蒸発器４の入口冷媒温度を検知するサーミスタ２１からの信号と蒸発器４の出口冷媒温度を検知するサーミスタ２３からの信号が入力され、これらの信号を基に、蒸発器４出口の冷媒状態に応じて電気式膨張弁８の開度を制御するように構成されている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００７５】
次に本実施の形態の圧縮機運転中のコントローラ２０の動作について説明する。コントローラ２０には、サーミスタ２１より検出された蒸発器４の入口冷媒温度Ｔ１とサーミスタ２４より検出された蒸発器４出口の冷媒温度Ｔ４が入力され、この２つの温度差Ｔ４－Ｔ１により蒸発器４の出口冷媒の過熱度を演算する。そしてこの過熱度Ｔ４－Ｔ１が予め定められた適正な設計値、例えば５℃となるように電気式膨張弁３へ開度指令を出力する。すなわちサーミスタ２１、２４によって検知した蒸発器出口冷媒過熱度が設計値よりも大きな値の時は、電気式膨張弁３の開度を現在よりも大きくするように開度指令を出力し、逆にサーミスタ２１、２４によって検知した蒸発器出口冷媒過熱度が設計値よりも小さな値の時は、電気式膨張弁３の開度を現在よりも小さくするように開度指令を出力する。

【００７６】
従来の冷蔵庫では、固定絞りである毛細管が絞り装置と用いられていたため、冷蔵庫の使用条件によっては、圧縮機起動時などに蒸発器出口冷媒過熱度が常に最適値に制御できず、蒸発器出口が気液二相状態となったり、過熱度の大きな過熱蒸気状態となる場合があった。蒸発器出口が気液二相状態となった場合には、未蒸発の液冷媒が蒸発器から流出するため、冷凍能力が低下し、冷蔵庫のエネルギー効率が低下する。一方、蒸発器出口が過熱度の大きな過熱蒸気状態となった場合には、過熱蒸気冷媒の伝熱特性は、気液二相冷媒よりも悪いため、蒸発器の熱交換効率が低下し、やはり冷蔵庫のエネルギー効率が低下する。

【００７７】
しかし本実施の形態では、圧縮機の断続運転により庫内の温度を一定に制御している家庭用冷蔵庫において、圧縮機起動時も含めて常に蒸発器４の出口冷媒の過熱度を最適値となるように電気式膨張弁３で制御しているので、未蒸発の液冷媒が蒸発器から流出したり、蒸発器の熱交換効率が低下したりすることはなく、冷蔵庫のエネルギー効率を向上させることが出来る。

【００７８】
実施の形態４．
図４はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、電気式膨張弁３のコントローラ２０には、電気式膨張弁３の入口冷媒温度を検知するサーミスタ２５からの信号と凝縮器２の出口冷媒温度を検知するサーミスタ２６からの信号が入力され、これらの信号を基に、電気式膨張弁３出口の冷媒状態に応じて電気式膨張弁３の開度を制御するように構成されている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００７９】
次に本実施の形態の圧縮機運転中のコントローラ２０の動作について説明する。コントローラ２０には、サーミスタ２５より検出された電気式膨張弁３の入口冷媒温度Ｔ５とサーミスタ２６より検出された凝縮器２出口の冷媒温度Ｔ６が入力され、この２つの温度差Ｔ６－Ｔ５により電気式膨張弁３の入口冷媒の過冷却度を演算する。そしてこの過冷却度Ｔ６－Ｔ５が予め定められた適正な設計値、例えば２℃となるように電気式膨張弁３へ開度指令を出力する。すなわちサーミスタ２５、２６によって検知した電気式膨張弁入口の冷媒過冷却度が設計値よりも大きな値の時は、電気式膨張弁３の開度を現在よりも大きくするように開度指令を出力し、逆にサーミスタ２５、２６によって検知した電気式膨張弁入口の冷媒過冷却度が設計値よりも小さな値の時は、電気式膨張弁３の開度を現在よりも小さくするように開度指令を出力する。

【００８０】
従来の冷蔵庫では、固定絞りである毛細管が絞り装置と用いられていたため、冷蔵庫の使用条件によっては、毛細管入口の気液混合割合が大きく変化し、蒸気冷媒が増加したり、液冷媒が増加したりしていた。毛細管入口の気液混合割合が変化すると、毛細管を通過する冷媒流量も変動し、冷凍能力が低下したり、冷蔵庫のエネルギー効率が低下する。ま

た毛細管入口部の気液二相冷媒の流動様式がスラグ流になると大きな冷媒流動音が発生する場合もあった。

【００８１】

しかし本実施の形態では、圧縮機の断続運転により庫内の温度を一定に制御している家庭用冷蔵庫において、圧縮機起動時も含めて常に電気式膨張弁８の入口冷媒の過冷却度を最適値となるように電気式膨張弁８で制御しているので、電気式膨張弁を通過する冷媒流量の変動はなく、冷蔵庫のエネルギー効率を向上させることが出来る。また電気式膨張弁入口の冷媒流動様式はスラグ流となることはなく、電気式膨張弁での冷媒流動音の発生を防止することができる。

【００８２】

実施の形態５．

図５はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、電子式膨張弁８の上流に毛細管８１、下流に毛細管８２が設けられている。また毛細管８１と圧縮機１の吸入配管は半田付けされ、熱回収熱交換器１０ａを構成し、毛細管８２と圧縮機１の吸入配管も半田付けされ、熱回収熱交換器１０ｂを構成している。電気式膨張弁８のコントローラ２０には、蒸発器４の入口冷媒温度を検知するサーミスタ２１からの信号と圧縮機１の吸入冷媒温度を検知するサーミスタ２２からの信号が入力され、これらの信号を基に、圧縮機１の吸入冷媒過熱度を最適値となるように電気式膨張弁８の開度を制御するように構成されている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００８３】

本実施の形態では、電気式膨張弁８の上流および下流に毛細管を設けて絞り装置を構成し、図１に示した電気式膨張弁のみで絞り装置を構成した実施の形態に比べて、スラッジなどの異物による詰りの発生の危険性を低減している。すなわち本実施の形態では、電気式膨張弁前後の毛細管にもスラッジが堆積するため、電気式膨張弁のみで絞り装置を構成したものに比べて、電気式膨張弁に堆積するスラッジ量を低減できる。このためスラッジによる電気式膨張弁詰りの危険性低減し、信頼性の高い冷蔵庫を提供することが出来る。

【００８４】

なお本実施の形態では、電気式膨張弁８の上流および下流に毛細管を設置する構成について示したが、これに限ることはなく、電気式膨張弁８の上流のみに毛細管を設置しても同様の効果を発揮する。また電気式膨張弁８の下流のみに毛細管を設置しても良い。

【００８５】

実施の形態６．

図６はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、電子式膨張弁８と並列に毛細管８８が設けられている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００８６】

本実施の形態では、電気式膨張弁８と並列に毛細管を設置しているため、図１に示した電気式膨張弁のみで絞り装置を構成した実施の形態に比べて、電気式膨張弁を通過させる冷媒流量を低減でき、小形で安価な電気式膨張弁を使用することが出来る。また電気式膨張弁のみで絞り装置を構成したものに比べて、毛細管を並列に設置することにより、電気式膨張弁に堆積するスラッジ量を低減でき、スラッジによる電気式膨張弁詰りの危険性低減し、信頼性の高い冷蔵庫を提供することが出来る。さらに万一、スラッジや異物により電気式膨張弁が閉塞した場合でも、冷媒は毛細管を通過することが出来るため、必要最低限の運転を維持することが出来、信頼性の高い冷蔵庫を提供することが出来る。

【００８７】

実施の形態７．

図７はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の冷媒回路図で、圧縮機１には、回転数を任意値設定できるインバータ３５が接続されている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００８８】
本実施の形態では、可燃性冷媒を用いた家庭用冷凍冷蔵庫の圧縮機として、回転数が可変のインバータ駆動圧縮機を用いることにより、エネルギー効率の向上を図っている。すなわち、夜間など冷蔵庫の設置された周囲空気温度が低く、また冷蔵庫の扉開閉がほとんどなく、冷蔵庫の熱負荷が小さい場合には、圧縮機１の回転数をインバータ３１によって小さくし、圧縮機の電気入力を小さくした状態で運転することにより、冷蔵庫のエネルギー効率を向上させることができる。また圧縮機１の回転数を減少させると、冷凍サイクルの冷凍能力が減少し、圧縮機断続回数が低減できるため、圧縮機の断続運転に伴う冷媒移動やエネルギー損失も低減でき、エネルギー効率は一層向上する。

【００８９】
インバータ３５による圧縮機１の回転数制御方法としては、冷蔵庫の設置された周囲空気温度を検知し、この周囲空気温度に応じて圧縮機回転数を制御する。すなわち、周囲空気温度が高い場合は、冷蔵庫の熱負荷も大きく、この時は圧縮機回転数を大きくして、大きな冷凍能力で運転する。また周囲空気温度が低い場合は、冷蔵庫の熱負荷も小さく、この時は圧縮機回転数を小さくして、小さな冷凍能力で運転する。なおこの際、冷蔵庫の扉開閉や庫内温度の情報をもとに、圧縮機回転数をさらに調整するように制御すれば、より一層エネルギー効率は向上する。

【００９０】
また本実施の形態の電気式膨張弁３の制御法としては、図１に示した実施の形態と同様に、圧縮機１の吸入冷媒過熱度が最適値となるように制御することにより、圧縮機１の回転数が変化しても、圧縮機１の吸入冷媒過熱度が常に最適に制御でき、圧縮機の信頼性が高く、しかもエネルギー効率の高い冷蔵庫を提供することが出来る。なお、この電気式膨張弁３の制御方法としては、これに限るものではなく、図２から図４に示した実施の形態のように、圧縮機１の吐出温度、蒸発器４の出口冷媒過熱度、電気式膨張弁３の入口冷媒過冷却度のいずれかを最適に制御するようにしても、同様の効果を発揮する。また圧縮機１の回転数情報から電気式膨張弁３の開度を制御してよい。すなわち圧縮機１の回転数が大きい時は電気式膨張弁３の開度を大きくし、逆に圧縮機１の回転数が小さい時は電気式膨張弁３の開度を小さくするように制御することにより、サイクルの状態を最適に制御でき、サーミスタが不要で、安価に、圧縮機の信頼性が高く、しかもエネルギー効率の高い冷蔵庫を提供することが出来る。

【００９１】
実施の形態８．
図８はこの発明の実施の形態の他の例を示す家庭用冷凍冷蔵庫の側面断面図および背面図であり、圧縮機１および凝縮器２、放熱用送風機４０は、冷蔵庫の背面下部に設置されている。なお、図１に示したものと同一の構成部品には同一符号を付して、その重複する説明を省略する。

【００９２】
本実施の形態では、圧縮機１と凝縮器２を接続する冷媒配管の一部である配管４１を、放熱用送風機４０の近傍、すなわち放熱用送風機４０が生み出す空気の流れの中に設置している。さらにこの冷媒配管４１の耐圧強度は、凝縮器２や蒸発器４などのこの冷媒配管４１以外の冷媒配管よりも小さく設計されている。すなわち放熱用送風機４０の近傍に置かれた冷媒配管は、静的な内圧強度や動的な疲労強度の面で、最も弱く設計されている。また放熱用送風機４０は圧縮機の運転中、停止中に係わらず、常に電源が供給され、冷媒配管４１の周辺に空気の流れを形成している。

【００９３】
従来の家庭用冷蔵庫では、冷凍サイクルを構成する冷媒配管の強度はさまざまで、冷媒配管の強度不足による冷媒漏洩は、さまざまな部位で発生する危険性があった。特に蒸発器４など冷蔵庫庫内の空間と連通した冷媒配管から可燃性冷媒が漏洩すると、庫内が爆発濃度になる可能性が高く、爆発事故が生じる危険性も高くなる。そこで本実施の形態では、冷蔵庫庫内空間と連通していない冷媒配管の耐圧強度を最も小さくし、庫内空間への可

燃性冷媒の流入を完全に防止し、冷蔵庫の安全性を高めている。さらにこの冷媒配管を常時運転するように制御した放熱用送風機の近傍に設置することによって、万一この冷媒配管４１から可燃性冷媒が漏洩した場合でも、放熱用送風機４０が生み出す気流によって、可燃性冷媒は拡散し、可燃濃度とならないようにし、爆発事故の発生を防止している。

【００９４】

放熱用送風機４０の駆動モータ４０αは送風用ファンの上流側に位置するので、万一冷媒が漏れ出しても、モータ４０αの通電によって漏れ出した可燃性冷媒に引火することがない。

なお、冷媒配管４１の内圧強度や疲労強度を小さくする手段としては、配管の肉厚を薄くすることや、円管ではなく楕円管を用いることによって配管強度を小さくすることが出来る。また配管の材料を変更したり、溶接強度を弱くしてもよい。

【００９５】

このように本実施の形態では、万一冷媒配管の強度不足により可燃性冷媒がサイクルから外部へ漏洩しても、可燃性冷媒が庫内空間に進入することはなく、しかも漏洩した可燃性冷媒は放熱用送風機によって拡散されるため、冷蔵庫外部でも可燃濃度となることはなく、冷蔵庫の安全性を向上することが出来る。また圧縮機停止中も、放熱用送風機を運転するように制御しているため、圧縮機停止時に冷媒漏洩が発生しても、確実に可燃性冷媒を拡散させることができ、冷蔵庫の安全性はより一層向上する。

【００９６】

実施の形態９.

図９は本発明の実施の形態１～８の冷蔵庫を通信回線を介して制御可能にした例を示すシステム構成図である。この例では建物内の通信回線に電灯線を使用している。

図９において、２０は上記実施の形態１～７に記載されたコントローラ２０、５０は実施の形態８に記載された冷蔵庫本体であり、その他の構成は各実施の形態と同じなので説明を省略する。

【００９７】

１００は冷蔵庫５０のコントローラ２０と電灯線とを接続する制御基盤で、コントローラ２０と接続され、コントローラと制御信号の授受をする制御手段（マイコン）１０１と、この制御手段１０１と電灯線とを結び、通信手段１０３、変・復調手段１０４および結合手段１０５から構成される電灯線通信インターフェース１０２とを備える。

【００９８】

２００は電灯線と一般公衆回線（電話回線）３００とを接続する通信コントローラで、電灯線に接続される電灯線通信インターフェース２０１、赤外線等電灯線以外と接続される無線通信インターフェース２０２、電灯線通信インターフェース２０１および無線通信インターフェース２０２と接続されるモデム２０３並びにマイコン２０３と一般公衆回線３００とを接続するモデム２０３とを備える。

【００９９】

一般公衆回線３００からは外部の携帯電話、更にはインターネット回線を通じて携帯情報端末や電力会社、セキュリティ会社、サービス会社、冷蔵庫の製造者等と相互に接続され、コントローラ２０と相互に送受信可能になっている。そして、このような通信システムを介して外部から、コントローラ２０に入ってくる冷蔵庫５０の情報を収集でき、また、外部からコントローラ２０を介して冷蔵庫５０を制御することができる。

【０１００】

本実施の形態によれば、コントローラ２０が圧縮機１の入口、出口、蒸発器出口または流量制御弁付近の冷媒の状態を監視しているので、その情報を使って冷蔵庫の運転状態や異常状態等を知ることができる。また、運転制御指令信号もわかるようにしておけば制御指令信号と冷媒状態とから冷蔵庫の異常状態を知ることもできる。さらに、運転状態等から可燃性冷媒が漏れたことを検知でき、これを外部から知ることができるので、外部からの遠隔操作で直ちに冷蔵庫（圧縮機）の運転を停止したり、または同様に通信システムに接続されている他の家電機器の通電を停止したりすることができる。

【０１０１】

また、上述した圧縮機吸入過熱度の設定値、圧縮機の吐出温度の設定値、蒸発器出口冷媒過熱度の設定値および電機式膨張弁入口の冷媒過冷却度の設定値等を運転状況や周囲環境、機器の経年変化等に応じて製造者やサービス会社が外部より設定変更することが可能である。監視するサーミスタ等は上述した実施の形態で使用するサーミスタをそのまま利用できるので、機能の増加に比べて部品点数の増加を抑えることができるから、リサイクル時等における解体性にも優れている。

【図面の簡単な説明】

【０１０２】

【図１】この発明の実施の形態１を示す家庭用冷蔵庫の冷媒回路図。

【図２】この発明の実施の形態２を示す家庭用冷蔵庫の冷媒回路図。

【図３】この発明の実施の形態３を示す家庭用冷蔵庫の冷媒回路図。

【図４】この発明の実施の形態４を示す家庭用冷蔵庫の冷媒回路図。

【図５】この発明の実施の形態５を示す家庭用冷蔵庫の冷媒回路図。

【図６】この発明の実施の形態６を示す家庭用冷蔵庫の冷媒回路図。

【図７】この発明の実施の形態７を示す家庭用冷蔵庫の冷媒回路図。

【図８】この発明の実施の形態８を示す家庭用冷蔵庫の側面断面図と背面図。

【図９】この発明の実施の形態９を示す家庭用冷蔵庫の通信システムを示すシステム構成図。

【図１０】従来の家庭用冷蔵庫の冷媒回路図。

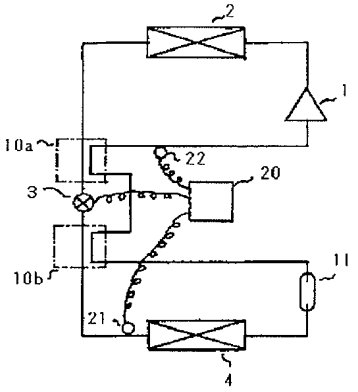
【図１１】従来の家庭用冷蔵庫の動作を示す特性図

【符号の説明】

【０１０３】

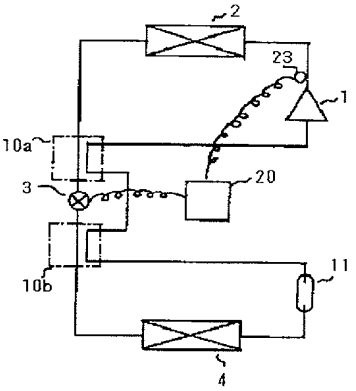
１　圧縮機、２　凝縮器、３　電子式膨張弁、４　蒸発器、１０　熱回収熱交換機、２０　コントローラ、２１　サーミスタ、２２　サーミスタ、３１　毛細管、３２　毛細管、３３　毛細管、３５　インバータ、４０　放熱用送風機。

【図１】



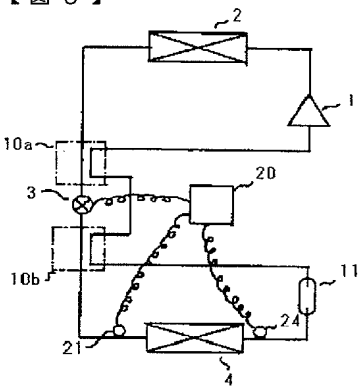
１．　圧縮機
２．　凝縮器
３．　電気式膨張弁（流量制御弁）
４．　蒸発器
１０ａ、１０ｂ．　熱回収熱交換器
１１．　ヘッダー
２０．　コントローラ（制御手段）
２１、２２．　サーミスタ

【図２】



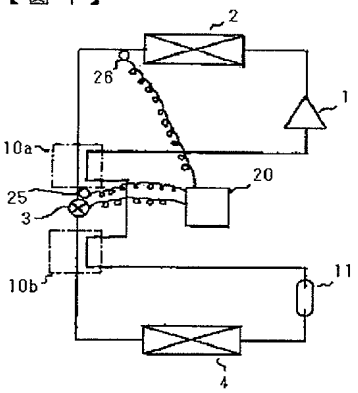
２３．　サーミスタ

【図３】



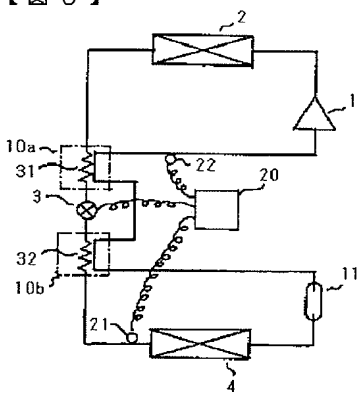
２４．　サーミスタ

【図４】



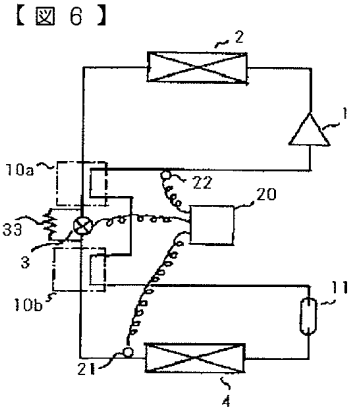
２５．　サーミスタ
２６．　サーミスタ

【図５】



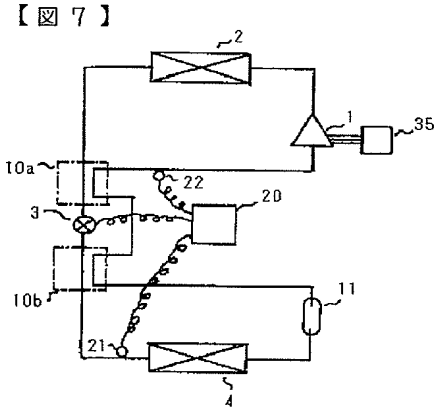
３１、３２．　毛細管

【図６】



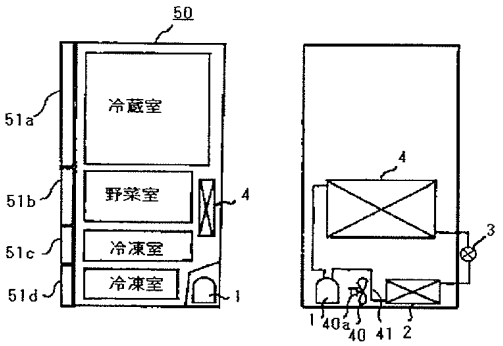
３３．　毛細管

【図７】



３５．　インバータ

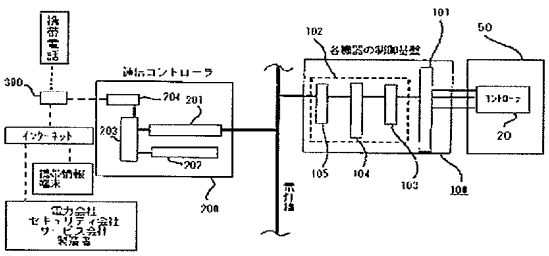
【図８】



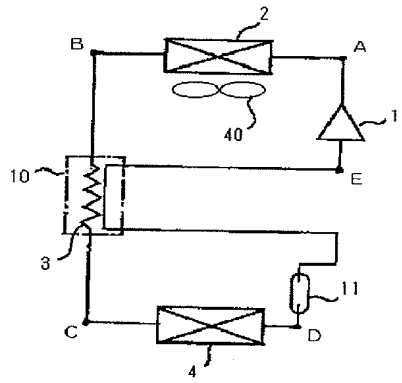
（側面断面図）　（背面図）

４０．　放熱用送風機
５０．　冷蔵庫本体
５１ａ～５１ｄ．　扉

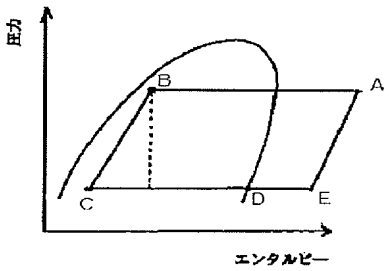
【図９】


101
102
50
300
201
203
202
105
104
103
108
20
208

【図１０】


2
B
A
40
1
10
E
3
11
C
D
4

【図１１】


圧力
B
A
C
D
E
エンタルピー

フロントページの続き

(51)Int.Cl.[7]	FI			テーマコード（参考）
	F25B	1/00	351B	
	F25B	1/00	361D	
	F25B	1/00	371F	
	F25B	1/00	395Z	
	F25D	11/00	101B	